UNIVERSITY OF WATERLOO

Undergraduate Studies Academic Calendar
2022-2023

Faculty of Engineering

Waterloo

Faculty of Engineering

Engineering & Architecture

Student Responsibility

This Calendar contains regulations that must be followed and requirements that must be satisfied to obtain a credential (e.g., degree, option, specialization) offered by the Faculty. All undergraduate students are also responsible for following the University Policies, Guidelines, and Academic Regulations.

Regulated Professions, Engineering and Architecture

The professions associated with engineering and architecture are both regulated.

Engineering

The practice of engineering is regulated, by statute, in all Canadian provinces and territories. To become a professional engineer a student must satisfy the requirements of the licensing bodies. These requirements include a degree from an accredited program, successful completion of a professional practice (law and ethics) examination, and suitable experience. The Bachelor of Applied Science (BASc) and Bachelor of Software Engineering (BSE) plans described in this Calendar have been specifically designed to satisfy the criteria of the profession and are evaluated regularly by the Canadian Engineering Accreditation Board (CEAB).

In the professional plans in engineering (BASc and BSE), each student's course of study must satisfy the curriculum-content requirements of the CEAB; accreditation of the degree by the CEAB is the mechanism by which graduates qualify for registration as professional engineers without the need to undertake additional examinations in specific technical subject areas. No student will be permitted to graduate who does not meet these requirements because this would jeopardize accreditation for the program. The department or board responsible for the appropriate plan will use these curriculum content requirements in determining the suitability of student elective course selections.

Architecture

The provincial architectural associations in Canada require that an individual intending to become an architect hold a professional degree in architecture accredited and/or certified by the Canadian Architectural Certification Board. Two types of degrees are accredited by the Board: (1) the Bachelor of Architecture, which currently requires a minimum of five years of study, except in Quebec, where four years of professional studies follows two years of Collège d'enseignement général et professionnel (CEGEP) studies and (2) the Master of Architecture, which currently requires a minimum of three years of study following an unrelated bachelor's degree or two years following a related pre-professional bachelor's degree. These professional degrees are structured to educate those who aspire to registration and licensure to practice as architects.

The four-year Bachelor of Architectural Studies, Honours degree, followed by the Master of Architecture degree constitute an accredited professional degree in architecture.

Three- and four-year pre-professional degrees, even when included in reviews of the professional programs, are not accredited by the Canadian Architectural Certification Board (CACB). These degrees are useful to those seeking a foundation in the field of architecture, as preparation for either continued education in a professional degree program or for other professional studies or employment options in fields related to architecture.

Degrees

The University of Waterloo awards the degree Bachelor of Architectural Studies (BAS), Honours, a pre-professional degree as well as the Master of Architecture, professional degree. The BAS degree is a co-operative study degree.

The degree Bachelor of Applied Science (BASc), Honours is awarded by the University in the following undergraduate plans:

Architectural Engineering
Biomedical Engineering
Chemical Engineering
Civil Engineering
Computer Engineering
Electrical Engineering
Environmental Engineering
Geological Engineering
Management Engineering
Mechanical Engineering
Mechatronics Engineering
Nanotechnology Engineering
Systems Design Engineering

The University of Waterloo also awards the degree Bachelor of Software Engineering (BSE), Honours.

Co-operative studies for Engineering students at Waterloo provide a completely integrated pattern of academic study and industrial experience in various phases of engineering or architecture with graduation requiring satisfactory performance in both areas. The degree covers almost five calendar years, comprising

eight terms each of about four-months on-campus study; alternately with six four-month terms of supervised training in the practical experiences fundamental to the development of the graduate engineer. The total time spent in academic study is the same as that encountered in the usual course of four academic years.

Dean's Honours List

To recognize outstanding academic achievement each term, the designation Dean's Honours List will be awarded to exceptional undergraduate Engineering students in each plan. To achieve this designation for a particular term, students must meet the following criteria for the term in question:

1. They must be unconditionally promoted at the end of that term (standings and official grades are available on Quest as specified in the Calendar of Events and Academic Deadlines).
2. They must have term decisions of Excellent and have received no penalties under Policy 71 during the term.
3. Their term averages minus their percentile ranks from the tops of their classes for that academic term must be greater than or equal to 80.
4. They must be in cohorts with 10 or more students.
5. Their course loads must equal or exceed the minimum number of academic units specified by their plan for that term.

This designation will be reflected on students' transcripts. Students not in the top 10% of their classes are normally not eligible.

Students with outstanding records throughout their undergraduate careers in Engineering will graduate on the Dean's Honours List if they have been on the Dean's Honours List for at least two of the six academic terms preceding graduation, and have cumulative averages over the final six academic terms of their plan of at least 80%. An appropriate notation will appear on students' official transcript.

Students enrolled in the Bachelor of Software Engineering (BSE) degree may also qualify for the Dean's Honours List using rules specified by the Dean of Mathematics. The process is described in detail in Software Engineering.

Workplace Hazardous Materials Information System (WHMIS) Requirements

All students taking courses offered by the Faculty of Engineering must have appropriate instruction on issues of safety. The Workplace Hazardous Materials Information System (WHMIS) instruction satisfies this requirement.

WHMIS training is offered for students as part of their instruction in their 1A term in Engineering (Bachelor of Applied Science and Bachelor of Software Engineering), and to all incoming 1A Architecture (Bachelor of Architectural Studies) students. This requirement must be satisfied by Architecture students by the end of the first month of the 1A term, or the student's enrolment in Architecture courses will be cancelled.

Undergraduate Communication Requirement

Each plan in the Faculty includes one or more courses that students must successfully complete to satisfy the Undergraduate Communication Requirement. These courses are:

- Architecture: ARCH 120
- Architectural Engineering: ENGL 191/SPCOM 191
- Biomedical Engineering: BME 101 and BME 101L
- Chemical Engineering: One of EMLS 101R, EMLS 102R, EMLS 129R/ENGL 129R, ENGL 109, SPCOM 100, SPCOM 223
- Civil Engineering: ENGL 191/SPCOM 191
- Computer Engineering: ENGL 192/SPCOM 192
- Electrical Engineering: ENGL 192/SPCOM 192
- Environmental Engineering: ENGL 191/SPCOM 191
- Geological Engineering: ENGL 191/SPCOM 191
- Management Engineering: ENGL 192/SPCOM 192
- Mechanical Engineering: ME 100
- Mechatronics Engineering: MTE 100
- Nanotechnology Engineering: One of EMLS 101R, EMLS 102R, EMLS 129R/ENGL 129R, ENGL 109, SPCOM 100, SPCOM 223
- Software Engineering: One of EMLS 101R, EMLS 102R, EMLS 129R/ENGL 129R, ENGL 109, ENGL 119, ENGL 209, ENGL 210E, SPCOM 100, SPCOM 223
- Systems Design Engineering: SYDE 101 and SYDE 101L

Standings and Promotions

In plans associated with the Bachelor of Applied Science (BASc) and Bachelor of Software Engineering (BSE) degrees, and in the program associated with the Bachelor of Architectural Studies (BAS) degree, each student's progress is assessed at the end of each academic term. At that time a promotion decision is assigned. If the student is promoted, they are expected to return to the next academic term at an appropriate time. There are two sets of rules used for promotion decisions: one for the BASc and BSE students based on term averages and cumulative failed courses, and a different set of rules for BAS students based on term and cumulative averages as well as specific course grades.

The promotion rules associated with BASc and BSE students are located in Examinations and Promotions. The promotion rules associated with BAS students are located in Regulations, Examinations and Promotions of the School of Architecture section.

Absences

Students encounter situations that may interfere with their ability to complete a regularly scheduled term of study. In such cases, students may either not register for a given term or consider a voluntary withdrawal. If the absence exceeds one year, students should refer to the Request to Complete Degree Requirements Following an Absence below.

Failure to Register

Students who do not enrol in courses for the term in which they would normally be expected to return and who do not submit an Undergraduate Notice of Withdrawal Form or otherwise obtain the permission of the department, prior to the final registration date as defined in the Fees section of this Calendar, will be deemed to have withdrawn from the Bachelor of Architectural Studies (BAS), Bachelor of Applied Science (BASc), or Bachelor of Software Engineering (BSE) program. Permission to return to classes is considered according to the following rule: If the absence has not exceeded one year and the student has an acceptable standing (Excellent, Good, Satisfactory), then that student is permitted to return to study at a time appropriate to their plan. If students have a negative standing decision (such as Required to Repeat), then the date of return is subject to the constraints associated with that standing.

Voluntary Withdrawals

Students may withdraw from a term or from their plan depending on the time of the term and depending on any extenuating circumstances. In all cases, students must submit an Undergraduate Notice of Withdrawal Form. The following describes the criteria and constraints for each of these alternatives.

- Students may withdraw from the (entire) term, without academic penalty, at any time prior to the start of the Drop with WD Period. Students must notify their academic advisor and complete the appropriate forms.
- The courses taken by students who withdraw from a term during the Drop with WD Period remain on the transcript and are recorded as WD (Withdrew after the drop deadline). The term decision is recorded as Not Applicable. Students may request to return to their studies one year after the start of the term withdrawn from.
- The courses taken by students who withdraw from a term during the Drop with WF Period remain on the transcript and are recorded as WF (Withdrew Failure). The term decision is Required to Withdraw. Students may apply for readmission one year after the start of the term withdrawn from.

Students who voluntarily withdraw from a term are expected to return to their plan of study within one year from the beginning of the term from which they withdrew. After this period, if students have not enrolled in their plan, they will be deemed to have withdrawn from the Bachelor of Architectural Studies (BAS), Bachelor of Applied Science (BASc), or Bachelor of Software Engineering (BSE).

Students who withdraw from their degree (BAS, BASc, or BSE), or are deemed to have done so, will be required to apply for readmission in order to be considered for continuation of their plan of study.

See the Calendar of Events and Academic Deadlines and the Fees section of this Calendar with respect to eligibility for refund of fees paid for the term.

For students in the 1A term, additional leniency may be permitted depending on the circumstances leading to the decision to withdraw.

Request to Complete Degree Requirements Following an Absence

The requirements and expectations for students wishing to return to their degree after a period away are described below. These requirements are for students who left their degree in good standing. Good standing refers to situations where students were permitted to return to their degree during their last academic term. It specifically does not include students that are required to withdraw from engineering.
Note: These requirements apply to all previously enrolled students in the Faculty of Engineering.

1. If students have not registered in classes for a period of less than one year, the promotion rules associated with that degree describe the return requirements (see Voluntary Withdrawals above).
2. If students have been away from study in their plan for a period of one year or more, their return is to be governed by the following alternatives:
    - Students who have been away for a period of less than six years can apply to complete the degree requirements that were in place at the time they left their degree. However, as plans evolve some courses may have changed and there may be a need to modify the exact sequence of the material but not to increase the normal load required to complete the degree. (It may be to a student's advantage to repeat some material prior to starting new material.)
    - Students who have been away for a period of six years or more and were no more than 1.5 units (weight) from completing their original degree requirements can apply to complete the degree requirements that were in place at the time they left their degree. Due to the evolution of our plans, there may be a need to modify exactly which courses are required to complete the degree.
    - Students who have been away for a period of six years or more and have more than 1.5 units (weight) to complete their degree are required to complete the degree requirements in effect at the time of their readmission.

Degree Completion Following 4B

Students who have completed a 4B term but have not yet met their degree requirements are normally expected to complete their degree requirements as soon as possible following the 4B term. This would mean that they are expected to take courses (if required) starting in the term immediately following 4B (if the course is available) and to complete any (permitted) co-op work terms in the term following 4B.

In the event that more than one year has elapsed since the completion of 4B and there has been no progress towards completing the degree, see the Request to Complete Degree Requirements Following an Absence.

Petitions, Grievances and Appeals

A **petition** (Policy 70) is a request for relief from a properly applied decision as a result of a documented special circumstance. A **grievance** (Policy 70) provides a process for a student who believes that a decision by a University authority, or action by a faculty member or a staff member of the University affecting some aspect of their university life, has been unfair or unreasonable. An **appeal** (Policy 72) provides a potential path to appeal a decision made under policies, including grievances in Policy 70. A complete description of grievances and appeals can be found in the appropriate University Policies, Guidelines, and Academic Regulations.

Petitions in Engineering

A petition is launched by submitting a Petition for Exception to Academic Regulations Form (70A). Reasons for such requests for special treatment must be provided with the petition. If a successful petition would reverse an academic decision, the petition must be received prior to four weeks after the date of issue of the grades for the corresponding term in order to facilitate entry into the immediately following term if so desired by the student. Petitions which are launched later than six months after the end of the term for which the decision would be affected normally will not be considered.

All petitions are considered by the Engineering Examinations and Promotions Committee. This committee will also acquire and consider the recommendation made by the student's home department, and by Co-operative Education if the petition concerns work-term considerations, before making its decision. Students normally do not appear in person before the committee unless an appearance will provide relevant information that cannot be communicated through the written petition and supporting documents. Requests for personal appearances will be considered by the associate dean of engineering for undergraduate studies.

Since a petition does not dispute an academic evaluation or application of the rules and regulations of the University, the decision of the Engineering Examinations and Promotions Committee with regard to petitions is final; there is no appeal of an unsuccessful petition.

Interdisciplinary Alternatives

Many Engineering students seek to enhance their degree with material from other disciplines and plans. There are several officially recognized alternatives available to Engineering students.

- **Options** within the Faculty of Engineering, open to Bachelor of Applied Science (BASc) and Bachelor of Software Engineering (BSE) students only, are described in Options, Specializations and Electives

for Engineering Students. There is also the Society, Technology and Values Option offered by the Centre for Society, Technology and Values within Engineering available to students from all faculties.
- **Minors** are offered by other faculties and described in that faculty section of the Calendar. All Engineering students can pursue minors. The Entrepreneurship Minor is open to all students from all faculties.
- Information regarding joint honours alternatives between Engineering and other faculties is described in Joint Honours Plans in Engineering.

It should be noted that for all of these alternatives, Engineering students must meet the criteria for their degree (BAS, BASc, or BSE) as well as the requirement of the option, minor, or joint honours major. This usually requires extra courses in addition to their degree.

Entrepreneurship Minor

The Conrad School of Entrepreneurship and Business offers an eight-course Entrepreneurship Minor that can be taken by undergraduate students in all faculties. Engineering students can take either the minor or the option, but not both.

To be awarded the Entrepreneurship Minor, students must complete all courses (core and electives) with a minimum overall average of 65% and no course with a grade less than 60%, as well as completing milestone requirements.

Three core courses:

- BET 100
- BET 320
- BET 340

Five electives:

1. A minimum of three additional BET courses.
2. Up to two more BET courses, third- or fourth-year electives available through the student's home faculty as approved by the minor co-ordinator. A guiding principle for approval of discipline-based elective courses is that they support the experiential milestone.

Specification for the Milestone Associated with the Entrepreneurship Minor

Experiential education is a critical component of the Minor. As such, students must participate in a milestone related to entrepreneurship. One possible milestone is an Enterprise Co-op (E Co-op) credit or Entrepreneurial Experience Term for non co-op students, pursuing opportunities that lead to the formation of commercial or social venture. Other milestones include a capstone-style: project, thesis, major project course, or a senior course containing a major assignment that could lead to a corporate enhancement or social contribution. Approval of capstone milestones as an appropriate entrepreneurial experience will rest with the minor's academic co-ordinator. This approval will be based on whether the proposed capstone satisfies the experiential intent of the plan, as well as, having a suitable faculty supervisor for the project.

E Co-op Milestone: This milestone is only available to students in co-op and requires successful completion of the following:

1. Completion of an approved E Co-op term, approval based on an application and interview with the co-ordinator, and demonstration that there is an accessible market, realistic potential to create and deliver the proposed product or service, and a suitable work plan.
2. 100% attendance of workshops and presentations during the initial week of the term.
3. Submission of acceptable regular progress reports based on the agreed term work plan as assessed by the E Co-op co-ordinator.
4. Submission of an acceptable end-of-term progress report as assessed by the E Co-op co-ordinator.

Entrepreneurship Experience Term: This milestone is available to any student engaged in starting a business. It requires:

1. Approval of the entrepreneurial experience based upon an application and interview with the E Co-op co-ordinator. There must be an accessible market, realistic potential to create and deliver the proposed product or service, and a work plan. Note: It is expected that the experiential portion of this term will require engagement in the venture for 35 hours per week for a full 12- to 16-week term.
2. 100% attendance of workshops and presentations during the initial week of the term.
3. Submission of acceptable regular progress reports based on the agreed work plan as assessed by the E Co-op co-ordinator.

4. Submission of an acceptable end-of-term progress report as assessed by the E Co-op co-ordinator.

Capstone, Thesis, or Project/Senior-Level Course with Major Assignment: This milestone is available to any student. It requires:

1. A capstone project, thesis, or project/senior-level course with a major assignment satisfying the entrepreneurial experience requirement of the plan, as determined by the minor academic co-ordinator.
2. The milestone must have a faculty supervisor.
3. The milestone must be able to lead to a potential commercial or social application.
4. Students choosing the capstone design milestone must participate in the Esch Awards competition, the Hult Prize competition, Concept Grants, Velocity Fund Finals, or an equivalent as approved by the minor academic co-ordinator.

Joint Honours Plans in Engineering

Engineering does not offer joint honours academic plans to non-engineering students. However, Bachelor of Architectural Studies (BAS), Bachelor of Applied Science (BASc), and Bachelor of Software Engineering (BSE) students may undertake a joint honours academic plan with non-engineering academic units.

A joint honours academic plan requires meeting all requirements of both plans. Students who choose a joint honours academic plan may require extra courses. However, courses required by the other plan can often be used to satisfy some of the requirements of the technical electives or complementary studies course groups in the BASc or BSE program.

Society, Technology and Values Option

The Society, Technology and Values Option and courses administered by the Centre for Society, Technology and Values (CSTV) are open to students in all faculties.

Requirements

To complete the STV Option, students must meet Requirements A, B, C, and D.

Requirement A: STV Introductory Courses

Completion of two of the following courses with a minimum two-course average of 70%.

- STV 100 Society, Technology and Values: Introduction
- STV 202 Design and Society
- STV 205 Cybernetics and Society
- STV 208 Artificial Intelligence and Society: Impact, Ethics, and Equity
- STV 210/HIST 212 The Computing Society

Requirement B: STV Focus Courses

Completion of one of the following courses with a minimum grade of 70%.

- STV 201 Society, Technology and Values: Special Topics
- STV 302 Information Technology and Society
- STV 304 Technology in Canadian Society
- STV 305 Technology, Society and the Modern City
- STV 306 Biotechnology and Society
- STV 401 Society, Technology & Values: Advanced Topics

Requirement C: STV and Other Related Courses

Completion of two additional courses with a minimum two-course average of 70%, either:

- two other STV courses from those listed in Requirements A and B; or
- one other STV course from those listed in Requirements A and B, and one course that is shown to be relevant to STV subject matter and approach as well as to the research undertaken in Requirement D, and that is approved by the CSTV option co-ordinator; or
- two courses that are shown to be relevant to STV subject matter and approach as well as to the research undertaken in Requirement D, and that are approved by the CSTV option co-ordinator.

Requirement D: Research

Students may meet their research requirement in one of the following two ways:

1. Completion of STV 400 with a minimum grade of 70%. STV 400 is a supervised reading and research course on a technology-and-society area and topic approved by the CSTV option co-ordinator.
2. Students who do a fourth-year thesis or project in their home department may add a significant technology-society component or components to their thesis or project. The STV component(s) must

deal with technology-society aspects of their research topic. The topic must be approved by the CSTV option co-ordinator. The project will be graded by the CSTV option co-ordinator or other representatives of the CSTV, and must receive a minimum grade of 70%.

Further Information

Contact the Centre for Society, Technology and Values.

International Exchange Opportunities

The Faculty of Engineering, University of Waterloo, has student exchange arrangements with engineering schools in other countries. Engineering students may participate in exchanges to experience study in different cultural environments and to receive academic credit towards their plan requirements. Students undertaking a Bachelor of Architectural Studies (BAS), Bachelor of Applied Science (BASc), or Bachelor of Software Engineering (BSE) may participate in exchanges, subject to the various requirements of those exchange arrangements. The list of current exchange programs in the Faculty of Engineering is constantly evolving and can change at any time. A complete list of engineering exchange partners is available on the Faculty of Engineering International Exchange web page.

Bachelor of Applied Science and Bachelor of Software Engineering Specific Degree Requirements

Overview

The engineering curricula Bachelor of Applied Science (BASc) and Bachelor of Software Engineering (BSE) at the University of Waterloo provide a sound basis in mathematics, pure science, and engineering science and design. The plans that are offered within the BASc degree are: Architectural, Biomedical, Chemical, Civil, Computer, Electrical, Environmental, Geological, Management, Mechanical, Mechatronics, Nanotechnology, and Systems Design. The curriculum for each of the plans combines required core subjects essential to the field and elective subjects permitting considerable diversity. An important part of the curriculum is a series of electives in Complementary Studies Requirements for Engineering Students. Although the BSE degree has courses in common with the BASc degree, there are significant differences.

A more detailed explanation of co-operative education is given in Co-operative Education Program Regulations, as well as, specific requirements as noted under Examinations and Promotions and Work Terms.

Students are introduced to the operation and requirements of the co-operative system of study during the academic term (or terms) prior to their first work term.

Note

The University of Waterloo provides students with online services such as elective drop/add and degree status information. When dealing with the online system, students need to be familiar with the following terms: your program is Engineering, and your academic plan is Chemical Engineering, Civil Engineering, etc.

Admission

All first-year students enrol in September and spend the first fall term together at the University, after which they are divided into different streams depending on their plan of study. All students have the same total time on campus and in industry regardless of how their particular stream is scheduled. All students complete the last term of the plan together prior to graduation.

The following can be found in this Calendar:

- The admission categories, requirements, and procedures for all plans are outlined in the Admissions section.
- Stream information for each Engineering plan is indicated on the Study/Work Sequence page.
- Precise dates for the beginning and end of the various terms are shown in the Calendar of Events and Academic Deadlines.

Admission for Applicants Not Currently Completing Ontario Secondary School

Applicants must provide strong, recent grades in the required Ontario high school courses or their equivalent. Courses taken at Ontario Colleges of Applied Arts and Technology and similar non-university, post-secondary institutions elsewhere are normally not accepted as equivalent to the required high school courses. The University has developed special pre-university mathematics, physics, and chemistry courses which can be taken online as an alternative. To discuss admissibility and appropriate qualifying studies,

applicants are advised to contact the director of admissions for the Faculty of Engineering in the fall of the year prior to entering first year.

Admission to Advanced Standing

Admission beyond 1A term is limited to applicants who have an academic and work experience background that is considered equivalent to the particular class they would join. Due to the co-operative nature of a Faculty of Engineering plan, no student will be admitted above 3A. Any student admitted to the 3A term will be required to enrol in the winter term, and to complete satisfactorily the final four academic terms, and the final three work terms and work reports.

Credit for previous work experience can be applied only to those work terms preceding the level of admission and cannot exceed three work terms. Students who are readmitted to an engineering plan are required to clear all previous failures.

Admission of Applicants with a Technical Degree

Applicants who already possess an undergraduate degree in a technical area such as engineering, science, or mathematics will normally be considered for admission into an undergraduate engineering plan only if space remains after all other qualified applicants have been considered. Postgraduate or graduate studies may be more appropriate for these applicants.

Examinations and Promotions

References to Engineering includes students enrolled in either the Bachelor of Applied Science (BASc) or Bachelor of Software Engineering (BSE) degree. References to associate chair are to be interpreted as either the associate chair, director, board chair, or the director of first-year engineering depending on the specific plan, and level.

Introduction

Bachelor of Applied Science (BASc) and Bachelor of Software Engineering (BSE) Students

The Faculty of Engineering (and Faculty of Mathematics for BSE students) constitutes the examining body for all examinations and is responsible for all decisions on grades, promotions, failures, deferred examinations, appeals, and recommendations for the granting of degrees. Authority in these matters is delegated to the Engineering Examinations and Promotions Committee. Students are examined and grades are set for individual courses on the completion of work for those courses. Upon examination of the student's performance at the end of each term, the Engineering Examinations and Promotions Committee assigns an academic decision.

BASc and BSE Promotion

Course Load

Normally, students are expected to enrol in a full-load term where they will take the number of courses specified by their plan. Students may reduce their load with the approval of their academic advisor. If extenuating circumstances are present, students should discuss their situation with their academic advisor, AccessAbility Services, or Campus Wellness-Health Services (including Counselling Services).

Reduced Load

In a reduced-load 1A term, students are permitted to drop two plan-specific courses with the approval of their academic advisor. Students on a reduced-load 1A term will complete their 1A term requirements during a second reduced-load 1A term. Students who complete their 1A term requirements in two successful reduced-load 1A terms join the 1B class in their plan one year after the 1B term that they would have qualified for had they completed 1A in one full-load term. The exact timing of the reduced-load term is dependent on the students' plan. Students should discuss this alternative with an academic advisor prior to requesting a reduced load.

In 1B and above, students are allowed to drop one elective course per term with the approval of their academic advisor.

Calculation of Term Averages and Course Grades

Term average: The primary factor in academic decisions in Engineering. The minimum passing average is 60%. The minimum average to remain in an Engineering plan is 50%. The term average is calculated using the weight of the course, the status of the course (e.g., Degree Requirement [in failure count] Not in Average [DRNA]) and the interpreted course grade. All grades above 32 are interpreted as the submitted

grade. Courses with a submitted grade below 32 are interpreted, for averaging purposes, as having a value of 32.

Course grade: A secondary factor in academic decisions in Engineering. The minimum passing course grade is 50%. A course for which the grade is below this is a failed course. The term "required courses" will be used to denote those courses which are required for the degree. Required courses that are dropped or failed must be successfully passed, or approved replacement courses passed, prior to graduation.

Dropped and Failed Courses

Some dropped or failed courses (type blank and DRNA courses as per Rule 3) may be carried forward unless a student accumulates a total of three such courses, at which time a student May Not Proceed until they have cleared the courses (by passing the course, replacing the course, or in some cases passing a supplemental examination) as described in Rule 6**.** The cumulative number of dropped and failed courses of type blank or DRNA is referred to as the To Be Cleared (TBC) count. Other failed courses (type Degree Requirement [not in TBC count] Not in Average [DRNC] courses as per Rule 1) must be passed by a certain point in a students' plan or a May Not Proceed decision will be applied (see Rule 12). The due date for completion of such courses is referred to as the completion date. Courses that are failed but not required for a students' plan do not have to be cleared.

The minimum requirements in a full-load term (except in a repeat term) for an academic decision which permits a student to proceed to the next term are a passing term average of 60%, a TBC count of less than three and no DRNC courses that have a grade less than 50 and have passed their completion date.

Repeated Term

If a term is being repeated, the minimum requirements to remain in their engineering plan are a term average of at least 60% and no grades below 50% for courses included in the term average.

Passing Failed or Dropped Required Courses

Failed and dropped required courses may be passed by one of the actions listed below. The department or board responsible for the student's plan of study will decide which mechanism is appropriate on a case-by-case basis.

- For a failed course:
    1. By obtaining a grade of 50% or more for the course based on the outcome of a supplemental examination for which there is a fee. Supplemental examinations may not be available for all courses. The associate chair for undergraduate studies is responsible for administering the supplemental examination and for determining the final supplemental grade to be assigned for the course. If a supplemental exam is permitted to clear the course, but has not yet been taken, a note of "Supplementary Exam Allowed" is provided on the transcript. When a supplemental examination is passed, the note is modified to "Satisfied" on the transcript. If the supplemental exam is not passed then a grade of "Not Satisfied" is associated with the supplementary exam on the transcript. Only one attempt at a supplemental examination is allowed; if this is not successful, the student must retake the course or, if appropriate, take an equivalent course approved by the department.
    2. By retaking the course, taking an equivalent course approved by the department or board or, especially for elective courses, taking an approved replacement course and obtaining a grade of 50% or more for the course. When a failed course has been successfully retaken or replaced, "Fail Cleared" is added on the transcript as a note. A retaken or replacement course also appears on the transcript in the normal fashion. If a grade of less than 50% is obtained for a retaken or replacement course, see Rule 6 and Rule 9.
- For a dropped course:
    1. By taking the course during a non-academic term and obtaining a grade of 60% or more for the course.
    2. By taking the course during an academic term, obtaining a grade of 50% or more, and including it in the term average.

All failed or dropped required courses must be passed prior to graduation. It is in the best interest of students to pass failed or dropped required courses as soon as possible. Students may not accumulate more than two TBC courses and continue in the plan. A student who obtains a passing term average but has accumulated three or more TBC courses will not be permitted to proceed to the next term; normally, a

student will be required to enrol instead for a non-degree term to pass some or all of the TBC courses. Only after the number of TBC courses still uncleared is reduced to one or none will the student be permitted to proceed to the next degree term.

Academic Decisions

At the end of each term, the examining faculty members submit grades for that term's courses. Each department or board then reviews the performance of its students and makes recommendations to the Engineering Examinations and Promotions Committee. The Engineering Examinations and Promotions Committee then considers the evidence on which the recommendations have been made and assigns the official academic decision. An appeal or petition relating to an assigned academic decision, grade, or other evaluation, or relating to other decisions based on University policies, may be made by following the procedures outlined in Petitions, Grievances and Appeals. All academic decisions and grades are reported to the student through the Office of the Registrar.

The possible academic decisions and their effect on the student's progress are as follows:

1. **Promoted** - proceed to next term. (Normally appears on transcripts as: EXCL, GOOD, SAT, or Promoted).
2. **May Continue in 1A, see advisor**. Student in a reduced-load term permitted to enrol in one more reduced-load term to complete 1A requirements. (Normally appears on transcripts as May Continue in 1A).
3. **May Continue in 1A no previous failed terms, see advisor**. This decision is similar to the May Continue in 1A decision above, however, is used in the case of students with a reduced load in their first 1A term in Engineering (and thus the student has zero previous failed terms). (Normally appears on transcripts as May Continue in 1A No Penalty).
4. **Conditional** - added to academic decision 1 or 3 to indicate that the student has adequate understanding of the term material to permit continuation, however, the failed course(s) must be cleared before graduation. (Normally appears on transcripts as Conditional).
5. **Academic Decision Deferred** - student may not proceed until specified conditions are satisfied. (Normally appears on transcripts as Decision Deferred).
6. **Required to Repeat Term** - a failed term academic decision requiring that the student repeat the most recent term. The student must stay out a minimum of two terms except for 1A before repeating. (Normally appears on transcripts as Failed - Must Repeat Term).
7. **May Not Proceed** - the student may not proceed to the next degree term or take required courses from that term until the academic decision has been changed to **Promoted** or to **Promoted (Conditional**). (Normally appears on transcripts as May Not Proceed).
8. **May Not Proceed COOP** - the student has three (or more) missing (or failed) work-term credits and may not proceed to the next term or take required courses from that term until the decision has been changed to **Promoted** or to **Promoted (Conditional)**.
9. **Required to Withdraw from Engineering** - the student's registration in their plan - Bachelor of Applied Science (BASc) or Bachelor of Software Engineering (BSE) - is revoked. Readmission is not possible for four academic terms following the term for which the decision applies. (Normally appears on transcripts as Failed - Required to Withdraw).
10. **Required to Withdraw after 1A Engineering** - the student's registration in their plan - Bachelor of Applied Science (BASc) or Bachelor of Software Engineering (BSE) - is revoked. Application for readmission may be considered for a qualifying readmission program immediately, however, the term of entry may vary depending on circumstance. (Normally appears on transcripts as Failed - Required to Withdraw from 1A).
11. **Aegrotat** - added to academic decision 1, 2, or 3; the term result is successful. The student has adequate understanding of the material, but because of illness or other extenuating circumstances, normal evaluation for at least one course was not possible. (Normally appears on transcripts as Aegrotat).
12. **Proceed on Probation** - a decision used in exceptional circumstances that allows the student to proceed to the next term. Continued progress in the plan is contingent on satisfying conditions which may be prescribed as the terms of probation. (Normally appears on transcripts as On Probation).

Rules

The following rules are applied when students' performance is assessed; unless otherwise stated the rules apply to reduced-load 1A, reduced-load, and full-load terms.

1. All (full-load) students are expected to enrol in at least the number of courses specified in this Calendar for the corresponding term of their plan. A reduced-load student may drop one elective

course per term (as defined by their plan) by obtaining the approval of their academic advisor. These are the courses used to calculate the term average, which is the basis of promotion decisions. Courses not included in the degree, term average, or failure count must be identified at the time of enrolment (see Rule 11). See Rule 15 for information regarding changing a course's designation. The designation of these courses may be changed (with the approval of the department) at any time prior to four weeks before the first day of the Final Examination Period for that term. Reduced-load 1A students must enrol in three courses (a load of at least 1.5 and normally less than a full load) as specified by their academic advisor. Normally, the reduced-load 1A term will be composed of at least two core courses from the 1A term with other courses specified by the academic advisor in consultation with the student.

2. Term decisions are described in the tables below. There are a number of decision descriptors that can be added to the decision described in the rules following the table. The term decision is based on the previous term decision, the term average for the current term, and the number of courses with grades below 50. The term average is calculated using the weight of the course, the status of the course (e.g., DRNA), and the interpreted course grade. All grades above 32 are interpreted as the submitted grade. Courses with a submitted grade below 32 are interpreted for averaging purposes, as having a value of 32. Both the number of courses below 50 in the current term as well as the cumulative number of To Be Cleared (TBC) courses on a student's record can be part of the decision.

Full- and reduced-load terms:

Previous Decision	**Term average greater than or equal to 60 and:** **1. No failed courses** **2. Full-load term, one or two failed courses, and less than three TBC courses** **3. Reduced-load term, one failed course, and less than three TBC courses** **4. TBC courses more than two, and term 2A or higher**	**Term average greater than or equal to 50 but less than 60, or Term average greater than or equal to 60 and either** **1. full-load term and more than two failed courses, or** **2. reduced-load term and more than one failed course**	**Term average less than 50**
Promoted	1. Promoted 2. Promoted (conditional) 3. Promoted (conditional) 4. May Not Proceed	Failed - Required to Repeat	Failed - Withdrawal Required
No previous term	1. Promoted 2. Promoted (conditional) 3. Promoted (conditional) 4. May Not Proceed	Failed - Required to Repeat	Failed - Withdraw from 1A
Failed - Required to Repeat	1. Promoted (if no failed courses) 2. Failed - Withdrawal Required (any failed courses) 3. Failed - Withdrawal Required (any failed courses) 4. Failed - Withdrawal Required	Failed - Withdrawal Required	Failed - Withdrawal Required

Reduced-load 1A terms:

Previous Decision	Term average greater than or equal to 60 and: 1. No failed courses 2. One failed course	Term average greater than or equal to 60 and more than one failed course, or term average greater than or equal to 50 but less than 60	Term average less than 50
No previous term	1. May Continue in 1A No Failed Terms 2. May Continue in 1A No Failed Terms (Conditional)	Failed - Required to Repeat	Failed - Withdraw from 1A
MC1A - May Continue in 1A, see advisor	1. Promoted 2. Failed - Withdrawal Required	Failed - Withdrawal Required	Failed - Withdrawal Required
MC1A0 - May Continue in 1A No Previous Failed Terms, see advisor	1. Promoted 2. Promoted (Conditional)	May Continue in 1A	Failed - Withdraw from 1A
Failed - Required to Repeat, see advisor	1. May Continue in 1A 2. Failed - Withdrawal Required	Failed - Withdrawal Required	Failed - Withdrawal Required

3. (Conditional) is appended to Promoted, May Continue in 1A, and May Continue in 1A No Failed Terms decisions if the student has a minimum average of 60% and fewer than three failed courses for a Promoted decision with a full-load term, or fewer than two failed courses for a Promoted decision with reduced-load term, or May Continue in 1A or May Continue in 1A No Failed Terms. The condition may be satisfied only by successfully clearing the failed course(s) (see the Introduction). Once the condition is satisfied, the (Conditional) is removed from the decision. No student may obtain the Bachelor of Applied Science (BASc) or Bachelor of Software Engineering (BSE) degree with an academic decision including (Conditional) remaining on their record. (Aegrotat) is appended to Promoted, May Continue in 1A, May Continue in 1A No Failed Terms, and Proceed on Probation decisions if one or more courses are graded as AEG (Aegrotat, credit granted under extenuating circumstances) and the other conditions for the decision are met.
4. While repeating the term, a student shall be excused from repeating individual courses in which a grade of 70% or better has been achieved. If this occurs, substitute courses, as approved by the department, must be taken, such that the student takes at least a reduced load in the repeat term.
5. (No Penalty) may be appended to the decision to repeat a term. In this case, the requirement to stay out for two terms before repeating the term is waived and the term is not counted as a repeat term with regard to the number of times a term can be repeated or in the calculation of the total number of terms of full-time study in the plan. This condition is normally applied as a result of extenuating circumstances which significantly affect the student's performance in the failed term.
6. A full-load student, at level 2A or higher, who achieves a minimum term average of 60% and has failed zero, one, or two courses in that term for a cumulative total of three or more TBC courses will receive the decision May Not Proceed (MNP). A reduced-load student at level 2A or higher, who achieves a minimum term average of 60% and has failed zero or one course in that term for a cumulative total of three or more TBC courses will receive the decision May Not Proceed. Normally, the student with MNP will enrol in a non-degree term devoted to retaking or replacing all or as many as possible of the TBC courses. In the event that some of the TBC courses are not available, the department may specify equivalent or appropriate alternative courses to be taken in their place. If the student is otherwise in good standing, the academic decision will be changed to Promoted when the number of TBC courses has been reduced to none. If the student is otherwise in good standing, the academic decision will be changed to Promoted (Conditional) when the number of TBC courses has been reduced to one. A student clearing TBC courses under this rule must achieve a minimum grade of 50% for failed courses and a minimum grade of 60% for dropped courses, otherwise the student will be Required to Withdraw from Engineering.
7. The plan must be completed in no more than 10 terms of full-time (full-load or reduced-load) study; that is, no more than two repeat terms are allowed. A student receiving a third failed term academic decision will be Required to Withdraw from Engineering. Both full-load and reduced-load students are in this category.
8. In extraordinary circumstances, a student with a term average below 60% may be allowed to Proceed on Probation or if any course grade is AEG (see Rule 3) may be allowed to Proceed on Probation (Aegrotat).

9. A student may be Required to Withdraw from Engineering at any time if in the opinion of the Faculty the student is unlikely to benefit from further participation in Engineering, the student leaves the plan without notification and fails to write examinations (receives a grade of DNW [Did not write examination, no credit granted, value 32] for some courses), or the student has made two or more unsuccessful attempts to clear the same failed course.
10. Courses taken by students during work terms will not be included in the average for any term. However, the grades for the courses taken at the University of Waterloo or at another university on a Letter of Permission will be reported on the student's transcript. Courses taken during work terms are eligible to be used towards a reduced-load term.
11. There are five types of courses applicable to Engineering undergraduate plans (BASc or BSE): depending on whether the course is part of the degree requirements, or not; whether the course will be included in term average calculations, or not; and whether the course is in the TBC count, or not. These courses are shown on the student record and transcripts as follows:

Description	Designation	Degree Requirement	In Average	In To Be Cleared (TBC) Count
Plan requirement, included in average	blank	Yes	Yes	Yes
Plan requirement, not included in average, in TBC count, supplemental exam (SUPP) not permitted	DRNA	Yes	No	Yes
Plan requirement, not in average, and not in TBC count	DRNC	Yes	No	No
Not required for plan, in average, not in TBC count	TRIA	No	Yes	No
Not required for plan, not in average	NRNA	No	No	No

With the exception of work-term reports (see Rule 17), a mixture of courses of type DRNA and courses of type TRIA will not be permitted in a single term. Grades for courses that are not included in the term average or not required for the plan will be reported on the student's transcript. Undergraduate students (BASc or BSE) are not permitted to enrol in any course in an audit category. The Faculty of Engineering does not permit other undergraduate students to enrol in Engineering courses in an audit category.

12. DRNC courses, while not in the TBC count, are normally associated with courses that must be completed by a certain point (i.e., must be completed before the end of 3A). That point is referred to as the completion date and is provided in the plan description portion of this Calendar for those plans that use DRNC courses. A student that has not completed the course successfully by the completion date will receive a May Not Proceed decision.
13. Although it is the Senate of the University that confers degrees, the Faculty of Engineering does recommend students for degrees in Engineering. A student who has successfully met all of the requirements will be Recommended for the BASc or BSE degree. The degree awarded will be the one associated with the plan of registration. A student who has demonstrated exceptional performance will be Recommended for the BASc or BSE Degree with Distinction. This recognition is granted to a student who has a cumulative average of 80% or greater, starting with their first enrolment in the 3A term, of those courses that are requirements for their plan, and that have been included in a corresponding term average (i.e., those courses of type blank above). Courses taken while on exchange, or terms for which the academic decision has Aegrotat added as a qualifier, do not contribute to the cumulative average. In such cases, the cumulative average will include the most recent four academic terms completed at Waterloo for which a numerical average is available.
14. Most courses at the University of Waterloo are assigned a numerical grade (between zero and 100) by the examiners. Any grade from zero to 32 is treated as having a value of 32 when averages (for promotions and awards) are calculated. Non-numerical grade definitions and university-level processes are included in the Grades section of this Calendar.
15. Changes to the set of courses included in the term average, which students take in a particular term, may be permitted at the discretion of the student's department. Such changes must normally be arranged and approved before the end of the Drop/Add Period, specified in the Calendar of Events and Academic Deadlines. After this period, only exceptional cases will be considered. Courses not included in the average in any academic term may be dropped at any time prior to the start of Drop with WF Period, and courses will be graded as WD (withdrew).

16. Students are expected to maintain a balance between the number of academic terms completed and the number of work-term credits earned. Situations that are defined as out of balance are characterized in the table below. For example: 1 (4) - meaning one work-term credit, four work-term opportunities, that would otherwise earn a decision permitting them to enrol in the next academic term, will receive a term decision of **May Not Proceed COOP** and will be unable to enrol in an academic term until they have completed at least two more work terms. Normally, this will require an absence from academic study for one year. During the one year following the academic term with this decision, the student is expected to find employment that can be treated as (at least) two work terms, recovering the work-term credits required to continue academically.
May Not Proceed COOP

Number of Credited COOP courses (minimum number of opportunities)
Current Academic Term (Excellent, Good, Satisfactory, Conditional)

Stream	2B	3A	3B	4A	4B
4	0 (3)	1 (4)	2 (5)	3 (6)	3 (6)
8	not applicable	0 (3)	1 (4)	2 (5)	3 (6)
4D	0 (3)	1 (4)	1 (4)	3 (6)	3 (6)
8D	not applicable	0 (3)	2 (5)	3 (6)	3 (6)
4S	0 (3)	1 (4)	2 (5)	3 (5)	3 (6)
8S	not applicable	0 (4)	1 (4)	3 (6)	3 (6)
8X	not applicable	0 (3)	1 (4)	3 (6)	3 (6)

Once the student has earned credit for two or more additional work terms, the term decision will be changed to the normal academic decision for the term.

17. Three work-term report credits are required of all BASc and BSE students. A work-term report credit is obtained by achieving a grade of satisfactory or better for a work-term report course. No student will be allowed to graduate without having achieved the required work-term report credits.

    Work-term report courses are specified in the plan section of this Calendar, and depending on the plan, may require reports, presentations, or some alternative method of meeting this requirement. If the plan specifies its own courses then those courses may be included in the term average, or excluded from the average. Some plans may use the common work-term report courses (WKRPT 200 or WKRPT 201, WKRPT 300 or WKRPT 301, and WKRPT 400 or WKRPT 401). For the plans using the shared courses, the following regulations are in place.

    Work-term reports submitted as one of the WKRPT courses are due seven days after the first official day of lectures of the academic term in which the report is required. Reports submitted after the deadline will receive grades of **Unacceptable (38)** and will be carried forward to the following academic term for evaluation, and are not eligible for prizes. Failed work-term reports are cleared by retaking the WKRPT course and passing it in a subsequent term.

    Work-term report courses WKRPT 200, WKRPT 300, and WKRPT 400 are considered to be required courses of type DRNA: failed work-term report evaluations contribute to the accumulated failed course count (see Rule 6). For failed work-term reports, the original grade will appear in the grade field. The failed course will be corrected by retaking and passing the course in a subsequent term.

    Work-term report courses WKRPT 201, WKRPT 301, and WKRPT 401 are considered to be required courses of type DRNC: failed work-term report evaluations do not contribute to the accumulated failed course count but will delay progress if not completed by the specified term (see Rule 12). For failed work-term reports, the original grade will appear in the grade field. The failed course will be cleared by retaking and passing the course in a subsequent term.

    When a work-term report (submitted as one of the WKRPT courses) has been submitted and the grade obtained is **Resubmit**, the student must provide any subsequent submissions by the date lectures end for that term, as specified in this Calendar, in order for those submissions to be considered in that term. Failure to clear a **Resubmit** by the lectures end date will result in a grade of **Unacceptable (38)**. Any submissions after the lectures end date will be deemed to be new submissions and to have been submitted for consideration in the following term.

Challenge for Credit

In unusual circumstances, a student may have received formal training, typically from an institution similar to the University of Waterloo, in material that they would normally be required to take as a course in their plan. In such cases, they may show evidence as to why they should be excused from taking the course. If the evidence is acceptable to the student's department, the student may be permitted to demonstrate competence in the material in a manner acceptable to the department offering the course. This process is known as Challenge for Credit. A Challenge for Credit cannot be used to recover from a failed course. Additional information may be obtained from the student's department. Where a Challenge for Credit is successful, the student is still expected to carry a full course load for the corresponding term; Challenge for Credit cannot be used to reduce the course load from the normal course load for any term. Challenge for Credit is available only for courses taught by the Faculty of Engineering.

Work Terms

The information provided here applies to students in the Bachelor of Applied Science (BASc) or Bachelor of Software Engineering (BSE) programs.

Academic Content and Evaluation

In the Faculty of Engineering, the experience gained during the work term is a significant component of Engineering. Associated with each work term are two components related to the degree: type and quality of the work performed by the student (captured in courses COOP 1 to COOP 6) and Professional Development (PD) courses (see below). The COOP courses are evaluated and a grade (credit or no credit) is assigned by Co-operative Education using criteria specified by the Faculty.

Professional Development

There are five Professional Development (PD) courses required for the BASc and BSE degrees. These courses are normally taken during work terms, and students are expected to enrol in one such course each work term until the requirement has been completed. The professional development criteria is composed of two core courses PD 19 and PD 20 (students are automatically enrolled in their first two work terms), and students begin to choose three PD elective courses in their third work term through Quest. These professional development courses are required, and of type DRNA (Degree requirement, not in average); failed courses contribute to the accumulated failed count (see Rule 6). If a student has taken a PD course in each work term, and the number of remaining work terms is less than the number of remaining required PD credits, the student may request permission to enrol in a PD course on an academic term. Questions and special requests related to enrolment alternatives are to be directed to the student's plan academic advisor.

Quantity

Upon entry to Engineering (including advanced admission), a student is expected to follow the work-term and academic-term sequence which corresponds to their specific plan. The minimum number of required satisfactory or better work terms is five. A sixth work term, although not required as part of the degree requirement, is available to students willing to meet the requirements.

Allowance can be made for personal considerations, educational opportunities, and other "On Own" conditions with prior approval from Co-operative Education. However, "On Own" conditions do not normally count toward the minimum requirements for graduation.

Rules and Regulations

Students should be familiar with the Co-operative Education Program Regulations of this Calendar regarding topics such as academic records and employers, failure to report, leaving without approval, strikes, commitment, on own studies, harassment, and in particular, co-op related appeal procedures and student status.

Unsatisfactory performance by a student on a work term is investigated. If it appears that the student will not benefit from proceeding, they may be required to withdraw from Engineering.

Study/Work Sequence

Legend for Study/Work Sequence Information Table

Key	Description
S/S	Engineering sequence/stream: 8=Stream 8, 4=Stream 4; 8D, 4D=two academic terms and two work terms back to back; 4F=both streams meet up in the 3B fall term; 8S and 4S=special sequencing of terms; 8X=one extended work term
F,W,S	Terms: F=September-December; W=January-April; S=May-August
1,2,3,4 plus A or B	Denotes academic year and term.
WT	Denotes scheduled work term.
1	The streaming for Computer and Electrical Engineering varies depending on demand.

Study/Work Sequence Information

Plan	S/S	F	W	S	F	W	S	F	W	S	F	W	S	F	W
Architectural	4S	1A	WT	1B	WT	2A	WT	2B	WT	3A	WT	3B	4A	WT	4B
Biomedical, Mechatronics	8X	1A	1B	WT	2A	WT	2B	WT	3A	WT	3B	WT	WT	4A	4B
Chemical	4D	1A	WT	1B	WT	2A	WT	2B	WT	3A	3B	WT	WT	4A	4B
Chemical	8D	1A	1B	WT	2A	WT	2B	WT	3A	WT	WT	3B	WT	4A	4B
Civil, Computer[1], Electrical[1], Management, Mechanical	8	1A	1B	WT	2A	WT	2B	WT	3A	WT	3B	WT	4A	WT	4B
Computer[1], Electrical[1]	4F	1A	WT	1B	WT	2A	WT	2B	WT	3A	3B	WT	4A	WT	4B
Environmental, Geological, Mechanical, Mechatronics, Systems Design	4	1A	WT	1B	WT	2A	WT	2B	WT	3A	WT	3B	WT	4A	4B
Nanotechnology	8S	1A	1B	WT	2A	WT	2B	WT	WT	3A	3B	WT	WT	4A	4B
Software	8	1A	1B	WT	2A	WT	2B	WT	3A	WT	3B	WT	4A	WT	4B

Complementary Studies Requirements for Engineering Students

In addition to technical knowledge and skill, the professional engineer requires an understanding of society. An ability to make intelligent judgments that encompass human and social values, as well as technical values, is inherent in that role. Such areas form an essential complement to technical studies in the education of an engineer. The Complementary Studies component of the curricula in Engineering (Bachelor of Applied Science or Bachelor of Software Engineering) requires that all students in Engineering receive instruction in the humanities and social sciences, engineering economics, communication, and the impact of technology on society.

The aim of the Complementary Studies component is to provide an understanding of our heritage and social environment, and of the ways in which science and engineering interact with them. These studies should develop sufficient interest to encourage further individual study.

Further objectives are that the Engineering student develop a broader intellectual outlook, a broader understanding of moral, ethical and social values, and an improved ability to communicate.

Requirements

The Complementary Studies component of the students' plan must satisfy the following:

1. At least one course must be taken that deals with the impact of technology on society. Courses which satisfy this requirement appear in List A – Impact Courses.
2. At least one course must be taken in engineering economics. Courses which satisfy this requirement appear in List B – Engineering Economics Courses. Note that core components of a plan may contain a course from this list.
3. At least two courses must be taken that deal with the central issues, methodologies, and thought processes of the humanities and social sciences. Courses that satisfy this requirement appear in List C – Humanities and Social Sciences Courses.
4. A minimum number of courses must be taken as required by a plan. The exact requirements vary according to plans; for details, see individual plan regulations. Courses which appear in Lists A, B, C, and D may be used to meet these requirements.
5. Provision must be made to develop the students' ability to communicate adequately both orally and in writing. The exact manner in which this requirement is satisfied varies according to plan; for details, see individual plan regulations.

Complementary Studies Course Lists

There are a number of other constraints that limit a students' selection from the lists below. These constraints are listed as notes at the end of this page.

Some courses may not be offered in the current academic year. Refer to the course offering lists (Schedule of Classes or Course Selection Offerings) or verify with the department offering the course.

List A – Impact Courses

- BET 360 Design Frameworks for Social Ventures
- BET 420 Entrepreneurship for Social Impact
- BME 381 Biomedical Engineering Ethics
- ENVS 105 Environmental Sustainability and Ethics
- ENVS 205 Sustainability: The Future We Want
- ERS 215 Environmental and Sustainability Assessment 1
- ERS 315 Environmental and Sustainability Assessment 2
- GENE 22A Topics for List A Complementary Studies Courses Taken on Exchange by Engineering Students
- GEOG 203 Environment and Development in a Global Perspective
- GEOG 207 Climate Change Fundamentals
- GEOG 368 Conservation/Resource Management of the Built Environment
- GSJ 205 Technology, Gender, and Social Justice
- MSCI 422 Economic Impact of Technological Change and Entrepreneurship
- MSCI 442 Impact of Information Systems on Organizations and Society
- NE 109 Societal and Environmental Impacts of Nanotechnology
- PACS 315 Engineering and Peace
- PHIL 226 Biomedical Ethics
- SOC 232 Technology and Social Change
- STV 100 Society, Technology and Values: Introduction
- STV 202 Design and Society
- STV 205 Cybernetics and Society
- STV 208 Artificial Intelligence and Society: Impact, Ethics, and Equity
- STV 210 The Computing Society
- STV 302 Information Technology and Society
- STV 304 Technology in Canadian Society
- STV 305 Technology, Society and the Modern City
- STV 306 Biotechnology and Society
- SYDE 261 Design, Systems, and Society

Other courses may be acceptable for this requirement. Prior approval is required from the student's department associate chair.

List B – Engineering Economics Courses

- AE 392 Economics and Life Cycle Analysis
- BME 364 Engineering Biomedical Economics
- CIVE 392 Economics and Life Cycle Cost Analysis
- GENE 22B Topics for List B Complementary Studies Courses Taken on Exchange by Engineering Students
- MSCI 261 Engineering Economics: Financial Management for Engineers
- SYDE 262 Engineering Economics of Design

List C – Humanities and Social Sciences Courses

Course scheduling is an evolving process at the University of Waterloo and it is difficult to ensure access to all possible Complementary Studies courses. One of the steps taken to improve students' chances of having access to their Complementary Studies courses for those terms that have a Complementary Studies course requirement, is that course components (lectures, tutorials, or labs) of core engineering courses will not be scheduled during specified time slots. Currently, these slots are Monday, Wednesday, and Friday from 11:30 a.m. to 12:30 p.m., as well as evening time slots on Monday or Tuesday from 7 p.m. to 10 p.m.

The following humanities and social sciences courses are permissible. In general, all literature and civilization courses in language departments are approved as humanities and social sciences courses.

Anthropology: All ANTH
Architectural Engineering: AE 101
Arts: ARTS 490 (Topic title: Global Engagement Seminar)
Business Entrepreneurship and Technology: BET 100, BET 300, BET 320, BET 340, BET 350, BET 400, BET 430, BET 450, BET 460, BET 580
Classical Studies: All CLAS

East Asian Studies: EASIA 100R
Economics: All ECON, except ECON 211, ECON 221, ECON 311, ECON 371, ECON 412, ECON 421, ECON 422, ECON 471
English: All ENGL, except ENGL 109, ENGL 119, ENGL 129R, ENGL 140R, ENGL 210E, ENGL 210F
Environment: ENVS 195, ENVS 205
Fine Arts (FINE): see home department associate chair
French Studies: FR 296, FR 297
Gender and Social Justice: All GSJ, except GSJ 371 (may be acceptable at the discretion of the associate chair when a course outline is shown)
General Engineering: GENE 22C (Topics taken on exchange by Engineering students), GENE 412
Geography and Environmental Management: GEOG 101, GEOG 202, GEOG 203, GEOG 368
Gerontology: GERON 201
History: All HIST, except HIST 400-level courses
Human Resources Management: All HRM
Human Sciences: HUMSC 101, HUMSC 102
International Studies: INTST 101
Kinesiology: KIN 352, KIN 354
Knowledge Integration: INTEG 120, INTEG 210, INTEG 220, INTEG 221, INTEG 251
Legal Studies: LS 101, LS 202
Management Sciences: MSCI 211, MSCI 263, MSCI 311, MSCI 411
Music: MUSIC 140, MUSIC 253, MUSIC 256, MUSIC 334, MUSIC 355, MUSIC 363
Peace and Conflict Studies: All PACS
Philosophy: All PHIL, except PHIL 145, PHIL 200J, PHIL 216, PHIL 240, PHIL 256, PHIL 257, PHIL 441
Planning: PLAN 100
Political Science: All PSCI, except PSCI 314, PSCI 315
Psychology: All PSYCH, except PSYCH 207, PSYCH 256, PSYCH 261, PSYCH 291, PSYCH 292, PSYCH 306, PSYCH 307, PSYCH 312, PSYCH 317, PSYCH 391; PSYCH 400-level courses need approval of the Department of Psychology
Public Health Sciences: HLTH 320
Recreation and Leisure Studies: REC 230, REC 425
Religious Studies: All RS
Sexuality, Marriage, and Family Studies: All SMF
Social Development Studies: All SDS, except SDS 150R, SDS 250R, SDS 251R, SDS 350R, SDS 398R, SDS 399R
Social Work: All SOCWK, except SOCWK 390A, SOCWK 390B, SOCWK 398R, SOCWK 399R
Society, Technology and Values: All STV
Sociology: All SOC, except SOC 221, SOC 280, SOC 322, SOC 498, SOC 499A, SOC 499B
Studies in Islam: SI 121R, SI 132R, SI 221R, SI 230R, SI 231R, SI 315R
Theatre and Performance: THPERF 100, THPERF 200

List D – Other Permissible Complementary Studies Courses

While the following courses may not be used to satisfy Requirements 1, 2, or 3, they may be used to satisfy Requirement 4. For details, see departmental regulations.
Accounting and Financial Management: AFM 131
Applied Language Studies: APPLS 205R, APPLS 301, APPLS 304R, APPLS 306R
Architectural Engineering: AE 491
Civil Engineering: CIVE 491
English: ENGL 109, ENGL 129R, ENGL 191, ENGL 192, ENGL 210E, ENGL 210F
English for Multilingual Speakers: EMLS 101R, EMLS 102R, EMLS 110R, EMLS 129R
Environment: ENVS 201, ENVS 401
Environmental Engineering: ENVE 391
Fine Arts (FINE): see home department associate chair
General Engineering: GENE 22D (Topics taken on exchange by Engineering students), GENE 315, GENE 415
Health: HEALTH 100, HEALTH 105
Management Sciences: MSCI 454
Music: MUSIC 100, MUSIC 231, MUSIC 240, MUSIC 246, MUSIC 254, MUSIC 255, MUSIC 260, MUSIC 361
Philosophy: PHIL 145, PHIL 200J, PHIL 216, PHIL 256, PHIL 257
Psychology: PSYCH 256, PSYCH 307, PSYCH 312, PSYCH 317
Recreation and Leisure Studies: REC 100
Speech Communication: SPCOM 100, SPCOM 191, SPCOM 192, SPCOM 223

Notes

1. Some University of Waterloo online courses may be taken during a student's work terms. Also, courses taken at another university during a work term may be eligible for a transfer of credit if approved by the student's associate chair for undergraduate studies.
2. Students who register early are most likely to get their choice. Attempts to register later may be prevented if the class is already at capacity.
3. For descriptions of the content of courses, see the Course Description section of this Calendar. These courses are usually listed under the subject code of the academic unit, board, or faculty responsible for offering the course, e.g., CIVE – Civil Engineering, PHIL – Philosophy, etc.
4. Students who wish to take linguistic and grammar courses must have their choices approved by their home department associate chair for undergraduate studies and, if approved, students must also be assessed by the language department to determine their skill level with the language. Such courses may only be used to satisfy Requirement 4 above.
5. Students are responsible for ensuring they have the necessary prerequisites.
6. Departments and boards may impose additional constraints with respect to the C and D lists of the Complementary Studies Requirements. Review the various plan descriptions for further information.
7. In exceptional circumstances, associate chairs for undergraduate studies may accept other courses as satisfying a specific Complementary Studies Elective (CSE) requirement. Normally, such consideration will only be given when students are returning from exchange or being offered advanced admission.
8. Access to some courses is not controlled by Engineering and students may not qualify for some courses on these lists.

Options, Specializations and Electives for Engineering Students

1. The Bachelor of Applied Science (BASc) and the Bachelor of Software Engineering (BSE) consist of two course groupings:
    - Compulsory core courses within the plan, and
    - Elective courses.
        - Complementary Studies Electives: Complementary Studies Requirements for Engineering Students and plan for more information.
        - Technical Electives: Courses usually chosen from Engineering department courses which will give some depth in the student's discipline. (See Engineering plan descriptions for listings of suggested elective course groupings of this type.) Students with special interests may, with the approval of their department associate chair (or academic advisor) structure individual elective course groupings.
2. The Faculty of Engineering recognizes both options and specializations within the BASc and BSE degrees. For students that meet the requirements for an option or a specialization, the credential is recognized on both the diploma and the transcript. Options are intended to recognize a field of study outside of the academic plan while specializations are intended to recognize success in a concentration within the electives available within the academic plan specification. Descriptions of the options are provided in BASc and BSE Specific Degree Requirements and descriptions of the specializations are within the specific plan descriptions. The options and option co-ordinators are listed on the designated options and co-ordinators web page. The option co-ordinator can assist in the organization and selection of courses for the option. Students are required to declare an option or specialization, using a Plan Modification Form, for it to be recognized as part of their degree and to appear on the diploma.
3. For an option or specialization to appear on the transcript, a student must achieve a minimum average of 60% in the option or specialization courses and a minimum grade of 50% in each course. Stricter grade requirements may be imposed for certain options or specializations.
4. Because options can require students to take extra courses, a student's academic standing must be such that the extra load will not lead to a high risk of failure, and permission of the department associate chair must be obtained. BSE students should refer to Software Engineering for options that are open to them.
5. Engineering offers one minor to students enrolled in Engineering. Many departments in other faculties also offer minors that may be of interest to Engineering students. Engineering students who choose a minor must take extra courses chosen from lists prepared by the discipline offering the minor. Courses in a minor may be used to satisfy some of the Technical Electives or Complementary Studies Electives.

6. In addition, students may take advantage of other opportunities including the Interdisciplinary Alternatives, the Accelerated Master's Programs, and a Concurrent Bachelor of Arts Degree (BA). A concurrent BA degree will require extra courses as well as agreement by both faculties of Arts and Engineering; interested students should consult their undergraduate advisor.

Faculty Options

Artificial Intelligence (Engineering) Option

The AI Option is available for students in all undergraduate Engineering plans at the University of Waterloo. The requirements for completion of the AI Option are:

All of

- ECE 457A Co-operative and Adaptive Algorithms or MSCI 435 Advanced Optimization Techniques
- MSCI 442 Impact of Information Systems on Organizations and Society

One of

- CS 480 Introduction to Machine Learning
- ECE 457B Fundamentals of Computational Intelligence
- MSCI 446 Introduction to Machine Learning

One of

- BME 356 Control Systems
- CHE 341 Introduction to Process Control
- ECE 380 Analog Control Systems
- MTE 360 Automatic Control Systems
- SE 380 Introduction to Feedback Control
- SYDE 352 Introduction to Control Systems

Three additional courses, at least one of which must be from Mathematics and at least one from Engineering, from the following list.

- CHE 522 Advanced Process Dynamics and Control
- CHE 524 Process Control Laboratory
- CO 456 Introduction to Game Theory
- CO 463 Convex Optimization and Analysis
- CO 466 Continuous Optimization
- CS 480 Introduction to Machine Learning
- CS 484 Computational Vision
- CS 485 Statistical and Computational Foundations of Machine Learning
- ECE 423 Embedded Computer Systems
- ECE 455 Embedded Software
- ECE 481 Digital Control Systems
- ECE 486 Robot Dynamics and Control
- ECE 488 Multivariable Control Systems
- MSCI 446 Introduction to Machine Learning
- MTE 544 Autonomous Mobile Robots
- STAT 341 Computational Statistics and Data Analysis
- STAT 440 Computational Inference
- STAT 441 Statistical Learning - Classification
- STAT 444 Statistical Learning - Advanced Regression
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 556 Simulating Neurobiological Systems
- SYDE 572 Introduction to Pattern Recognition

Note

Special topics courses may sometimes be appropriate for this Option; interested students should see the option co-ordinator for confirmation.

Biomechanics Option

The Biomechanics Option is available to all Engineering students.

The Option consists of seven courses selected from specified lists. At least one course must be taken as an "extra." An extra can be a course taken during a work term. Individual department requirements must be satisfied and thus the precise number of courses that need to be taken as extras (normally DRNA - see Rules for description) may vary. Contact the associate chair, option co-ordinator, or director for the plan for information regarding the number of extras as well as any other restrictions that may apply.

Option Requirements

The courses listed below may have prerequisites, and it is the student's responsibility to satisfy the requirements or otherwise obtain permission to enrol.

Legend

F - fall term; W - winter term; S - spring term

To satisfy the Option, students must successfully complete:

- one required course:
  - CIVE 460/ME 574 Engineering Biomechanics (W)
- one course from List A: Anatomy and Physiology (see Note 1)
  - BIOL 201 Human Anatomy (F)
  - BIOL 273 Principles of Human Physiology 1 (F,W), and a limited number of spaces may be available online (S)
  - BME 284 Physiological and Biological Systems (S)
  - KIN 100 Regional Human Anatomy and KIN 100L Regional Human Anatomy Laboratory (W)
  - SYDE 584 Physiological Systems and Biomedical Design (F)
- one course from List B: Ergonomics
  - KIN 121 Biomechanics of Human Movement and KIN 121L Biomechanics of Human Movement Laboratory (F)
  - KIN 320 Task Analysis (F)
  - KIN 420 Occupational Biomechanics (F) (see Note 2)
  - SYDE 162 Human Factors in Design (S)
  - SYDE 543 Cognitive Ergonomics (F)
  - SYDE 548 User Centred Design Methods (W)
- one course from List C: Techniques of Biomechanics
  - CHE 341 Introduction to Process Control (F,W)
  - CIVE 306 Mechanics of Solids 3 (F)
  - CIVE 422 Finite Element Analysis (W)
  - ECE 380 Analog Control Systems (W,S)
  - ECE 486 Robot Dynamics and Control (S)
  - ME 322 Mechanical Design 1 (F,W)
  - ME 360 Introduction to Control Systems (F,W)
  - ME 423 Mechanical Design 2 (F,S)
  - ME 547 Robot Manipulators: Kinematics, Dynamics, Control (W)
  - ME 555 Computer-Aided Design (W)
  - ME 559 Finite Element Methods (F,S)
  - ME 566 Computational Fluid Dynamics for Engineering Design (F,S)
  - MTE 360 Automatic Control Systems (F,W)
  - PHYS 395 Biophysics of Therapeutic Methods (W)
  - SYDE 352 Introduction to Control Systems (W)
  - SYDE 543 Cognitive Ergonomics (F)
  - SYDE 544 Biomedical Measurement and Signal Processing (W)
  - SYDE 553 Advanced Dynamics (F)
  - SYDE 572 Introduction to Pattern Recognition (W)
    SYDE 575 Image Processing (F)
- one course from List D: Kinesiology
  - BME 551 Biomechanics and Human Movement (W)
  - KIN 221 Advanced Biomechanics of Human Movement and KIN 221L Advanced Biomechanics of Human Movement Laboratory (W,S)
  - KIN 255 Fundamentals of Neuroscience and KIN 255L Fundamentals of Neuroscience Laboratory (F)
  - KIN 312 Introduction to Neurological Disorders (F)
  - KIN 340 Muskuloskeletal Injuries in Sport and Activity (F)
  - KIN 356 Sensory Systems Neuroscience (W)
  - KIN 416 Neuromuscular Integration (F)
  - KIN 420 Occupational Biomechanics (F) (see Note 2)
  - KIN 422 Human Posture, Balance and Gait (F)
  - KIN 425 Biomechanics Modelling (F)
  - KIN 472 Directed Study in Special Topics (F,W,S)

- plus a two-term project from List E: Project (see Note 3)
    - CHE 482 Group Design Project (F) and CHE 483 Group Design Project and Symposium (W)
    - CIVE 400 Civil Engineering Design Project 1 (S) and CIVE 401 Civil Engineering Design Project 2 (W)
    - ECE 498A and ECE 498B Engineering Design Project (F,W,S)
    - ENVE 400 Environmental Engineering Design Project 1 (F) and ENVE 401 Environmental Engineering Design Project 2 (W)
    - GENE 401 and GENE 402 Special Directed Studies (F,S,W)
    - ME 481 Mechanical Engineering Design Project 1 (F,S) and ME 482 Mechanical Engineering Design Project 2 (W)
    - NE 408 Nanosystems Design Project (F) and NE 409 Nanosystems Design Project and Symposium (W)
    - SYDE 461 Systems Design Capstone Project 1 (F) and SYDE 462 Systems Design Capstone Project 2 (W)

Notes

1. List A course is to be taken by the end of the student's 3B term.
2. KIN 420 may count towards List B or List D, but not both.
3. The project topic must be in the area of biomechanics and students are encouraged to have their projects supervised or co-supervised by a faculty member outside of their home department.

Computer Engineering Option

The Computer Engineering Option is available to all students in the Faculty of Engineering (including Architecture), except students in Computer Engineering. It requires a total of eight courses:

- Two of:
    - ECE 320 Computer Architecture
    - ECE 327 Digital Hardware Systems
    - ECE 423 Embedded Computer Systems
    - ECE 455 Embedded Software
- Five additional courses from the topics list below, one of which may be substituted with a course from the data structures and algorithms list.
- One course from List A Complementary Studies Requirements for Engineering Students that considers application of computing technology, or an alternative approved by the option co-ordinator.

The courses chosen to satisfy this Option must satisfy four additional constraints:

- They must satisfy Canadian Engineering Accreditation Board (CEAB) requirements.
- They must be approved by the option co-ordinator.
- Five of the courses must be considered elective (that is, not core requirements) in the student's academic plan. For the purposes of this Option, a course that a student could choose to graduate without will be considered elective.
- The student must have earned a minimum average of 75% in the selected courses in order to have earned the Option.

Students pursuing this Option are recommended to select courses in the areas of logic, digital hardware, operating systems, computing systems, databases, networks, and security and privacy.

Students may not declare this Option until they have completed both an introductory programming course and a data structures and algorithms course. Students must have a minimum average of 75% in these two courses in order to declare this Option.

The lists below are intended to be the same as for the Computing Option and the Software Engineering Option. These lists are also intended to include courses that are normally part of the Computing Minor offered by the Cheriton School of Computer Science. Other courses from Computer Science may be used towards this Option with permission of the option co-ordinator. Students may declare at most one of the Computing Option, Computer Engineering Option, or Software Engineering Option. Students may change which of the three Options they declare by contacting the option co-ordinator(s).

Introductory Programming

- AE 121 Computational Methods
- BME 121 Digital Computation
- CHE 120 Computer Literacy and Programming for Chemical Engineers
- CIVE 121 Computational Methods
- CS 115 Introduction to Computer Science 1

- CS 116 Introduction to Computer Science 2
- CS 135 Designing Functional Programs
- CS 145 Designing Functional Programs (Advanced Level)
- ECE 150 Fundamentals of Programming
- ENVE 121 Computational Methods
- GEOE 121 Computational Methods
- ME 101 Introduction to Mechanical Engineering Practice 2
- MSCI 121 Introduction to Computer Programming
- MTE 121 Digital Computation
- NE 111 Introduction to Programming for Engineers
- SYDE 121 Digital Computation

Data Structures and Algorithms

- BME 122 Data Structures and Algorithms
- CS 136 Elementary Algorithm Design and Data Abstraction and CS 136L Tools and Techniques for Software Development (see Note)
- CS 146 Elementary Algorithm Design and Data Abstraction (Advanced Level) and CS 136L Tools and Techniques for Software Development (see Note)
- CS 231 Algorithmic Problem Solving
- CS 234 Data Types and Structures
- ECE 250 Algorithms and Data Structures
- ECE 406 Algorithm Design and Analysis
- MSCI 240 Algorithms and Data Structures
- MTE 140 Algorithms and Data Structures
- SYDE 223 Data Structures and Algorithms

Note: Students who take CS 136 or CS 146 will also be required to enrol in CS 136L which is graded CR/NCR basis. However, passing CS 136L is not a requirement for the option and the course may be coded as NRNA.

Topics List

The following list of topics are organized into specific areas for readability.

Logic

- CS 245 Logic and Computation
- ECE 208 Discrete Mathematics and Logic 2
- SE 212 Logic and Computation

Databases

- CS 338 Computer Applications in Business: Databases
- ECE 356 Database Systems
- MSCI 245 Databases and Software Design

Operating Systems

- ECE 350 Real-Time Operating Systems
- MTE 241 Introduction to Computer Structures & Real-Time Systems
- SE 350 Operating Systems

Computing Systems

- ECE 252 Systems Programming and Concurrency
- ECE 351 Compilers
- ECE 454 Distributed Computing
- ECE 455 Embedded Software
- ECE 459 Programming for Performance

Networks

- ECE 358 Computer Networks

Digital Hardware

- BME 393 Digital Systems
- CS 230 Introduction to Computers and Computer Systems
- ECE 124 Digital Circuits and Systems
- ECE 222 Digital Computers
- ECE 224 Embedded Microprocessor Systems

- ECE 320 Computer Architecture
- ECE 327 Digital Hardware Systems
- ECE 423 Embedded Computer Systems
- ME 262 Introduction to Microprocessors and Digital Logic
- MTE 262 Introduction to Microprocessors and Digital Logic
- MTE 325 Microprocessor Systems and Interfacing for Mechatronics Engineering
- SYDE 192 Digital Systems

Software Engineering

- CS 445/ECE 451 Software Requirements Specification and Analysis
- CS 446/ECE 452 Software Design and Architectures
- CS 447/ECE 453 Software Testing, Quality Assurance and Maintenance
- MSCI 342 Principles of Software Engineering
- SE 463 Software Requirements Specification and Analysis
- SE 464 Software Design and Architectures
- SE 465 Software Testing and Quality Assurance

Human-Computer Interaction

- MSCI 343 Human-Computer Interaction
- MSCI 541 Search Engines
- MSCI 543 Analytics and User Experience
- SYDE 542 Interface Design
- SYDE 543 Cognitive Ergonomics
- SYDE 548 User Centred Design Methods

Security and Privacy

- ECE 409 Cryptography and System Security
- ECE 458 Computer Security

Pattern Analysis and Machine Intelligence

- ECE 417 Image Processing
- ECE 457A Co-operative and Adaptive Algorithms
- ECE 457B Fundamentals of Computational Intelligence
- ECE 457C Reinforcement Learning
- MSCI 436 Decision Support Systems
- MSCI 446 Introduction to Machine Learning
- MSCI 546 Advanced Machine Learning
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 552 Computational Neuroscience
- SYDE 556 Simulating Neurobiological Systems
- SYDE 572 Introduction to Pattern Recognition
- SYDE 575 Image Processing

Numerical Methods

- BME 411 Optimization and Numerical Methods
- CHE 322 Numerical Methods for Process Analysis and Design
- CIVE 422 Finite Element Analysis
- EARTH 456 Numerical Methods in Hydrogeology
- ECE 204 Numerical Methods
- ECE 204A Numerical Methods 1 and ECE 204B Numerical Methods 2
- ENVE 225 Environmental Modelling
- ME 559 Finite Element Methods
- ME 566 Computational Fluid Dynamics for Engineering Design
- MTE 204 Numerical Methods
- NE 336 Micro and Nanosystem Computer-aided Design
- SYDE 411 Optimization and Numerical Methods

Special topics courses as approved by the option co-ordinator.

Computing Option

The Computing Option is available to all students in the Faculty of Engineering (including Architecture), except students in Computer Engineering or Software Engineering. It requires six courses:

- At least one introductory programming course

- At least one data structures and algorithms course
- At least two topics courses
- Two additional courses selected from any list below

The courses chosen to satisfy this Option must satisfy four additional constraints:

- They must satisfy Canadian Engineering Accreditation Board (CEAB) requirements.
- They must be approved by the option co-ordinator.
- Three of the courses must be considered elective (that is, not core requirements) in the student's academic plan. For the purposes of this Option, a course that a student could choose to graduate without will be considered elective.
- The student must have earned a minimum average of 75% in the selected courses in order to have earned the Option.

Students may not declare this Option until they have completed both an introductory programming course and a data structures and algorithms course. Students must have a minimum average of 75% in these two courses in order to declare this Option.

The lists below are intended to be the same as the Computer Engineering Option and Software Engineering Option. These lists are also intended to include courses that are normally part of the Computing Minor offered by the Cheriton School of Computer Science. Other courses from Computer Science may be used towards this Option with permission of the option co-ordinator. Students may declare at most one of the Computing Option, Computer Engineering Option, or Software Engineering Option. Students may change which of the three Options they declare by contacting the option co-ordinator(s).

Introductory Programming

- AE 121 Computational Methods
- BME 121 Digital Computation
- CHE 120 Computer Literacy and Programming for Chemical Engineers
- CIVE 121 Computational Methods
- CS 115 Introduction to Computer Science 1
- CS 116 Introduction to Computer Science 2
- CS 135 Designing Functional Programs
- CS 145 Designing Functional Programs (Advanced Level)
- ECE 150 Fundamentals of Programming
- ENVE 121 Computational Methods
- GEOE 121 Computational Methods
- ME 101 Introduction to Mechanical Engineering Practice 2
- MSCI 121 Introduction to Computer Programming
- MTE 121 Digital Computation
- NE 111 Introduction to Programming for Engineers
- SYDE 121 Digital Computation

Data Structures and Algorithms

- BME 122 Data Structures and Algorithms
- CS 136 Elementary Algorithm Design and Data Abstraction and CS 136L Tools and Techniques for Software Development (see Note)
- CS 146 Elementary Algorithm Design and Data Abstraction (Advanced Level) and CS 136L Tools and Techniques for Software Development (see Note)
- CS 231 Algorithmic Problem Solving
- CS 234 Data Types and Structures
- ECE 250 Algorithms and Data Structures
- ECE 406 Algorithm Design and Analysis
- MSCI 240 Algorithms and Data Structures
- MTE 140 Algorithms and Data Structures
- SYDE 223 Data Structures and Algorithms

Note: Students who take CS 136 or CS 146 will also be required to enrol in CS 136L which is graded CR/NCR basis. However, passing CS 136L is not a requirement for the option and the course may be coded as NRNA.

Topics List

The following list of topics are organized into specific areas for readability.

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- CS 245 Logic and Computation

- ECE 208 Discrete Mathematics and Logic 2
- SE 212 Logic and Computation

Databases

- CS 338 Computer Applications in Business: Databases
- ECE 356 Database Systems
- MSCI 245 Databases and Software Design

Operating Systems

- ECE 350 Real-Time Operating Systems
- MTE 241 Introduction to Computer Structures & Real-Time Systems
- SE 350 Operating Systems

Computing Systems

- ECE 252 Systems Programming and Concurrency
- ECE 351 Compilers
- ECE 454 Distributed Computing
- ECE 455 Embedded Software
- ECE 459 Programming for Performance

Networks

- ECE 358 Computer Networks

Digital Hardware

- BME 393 Digital Systems
- CS 230 Introduction to Computers and Computer Systems
- ECE 124 Digital Circuits and Systems
- ECE 222 Digital Computers
- ECE 224 Embedded Microprocessor Systems
- ECE 320 Computer Architecture
- ECE 327 Digital Hardware Systems
- ECE 423 Embedded Computer Systems
- ME 262 Introduction to Microprocessors and Digital Logic
- MTE 262 Introduction to Microprocessors and Digital Logic
- MTE 325 Microprocessor Systems and Interfacing for Mechatronics Engineering
- SYDE 192 Digital Systems

Software Engineering

- CS 445/ECE 451 Software Requirements Specification and Analysis
- CS 446/ECE 452 Software Design and Architectures
- CS 447/ECE 453 Software Testing, Quality Assurance and Maintenance
- MSCI 342 Principles of Software Engineering
- SE 463 Software Requirements Specification and Analysis
- SE 464 Software Design and Architectures
- SE 465 Software Testing and Quality Assurance

Human-Computer Interaction

- MSCI 343 Human-Computer Interaction
- MSCI 541 Search Engines
- MSCI 543 Analytics and User Experience
- SYDE 542 Interface Design
- SYDE 543 Cognitive Ergonomics
- SYDE 548 User Centred Design Methods

Security and Privacy

- ECE 409 Cryptography and System Security
- ECE 458 Computer Security

Pattern Analysis and Machine Intelligence

- ECE 417 Image Processing
- ECE 457A Co-operative and Adaptive Algorithms
- ECE 457B Fundamentals of Computational Intelligence
- ECE 457C Reinforcement Learning
- MSCI 436 Decision Support Systems

- MSCI 446 Introduction to Machine Learning
- MSCI 546 Advanced Machine Learning
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 552 Computational Neuroscience
- SYDE 556 Simulating Neurobiological Systems
- SYDE 572 Introduction to Pattern Recognition
- SYDE 575 Image Processing

Numerical Methods

- BME 411 Optimization and Numerical Methods
- CHE 322 Numerical Methods for Process Analysis and Design
- CIVE 422 Finite Element Analysis
- EARTH 456 Numerical Methods in Hydrogeology
- ECE 204 Numerical Methods
- ECE 204A Numerical Methods 1 and ECE 204B Numerical Methods 2
- ENVE 225 Environmental Modelling
- ME 559 Finite Element Methods
- ME 566 Computational Fluid Dynamics for Engineering Design
- MTE 204 Numerical Methods
- NE 336 Micro and Nanosystem Computer-aided Design
- SYDE 411 Optimization and Numerical Methods

Special topics courses as approved by the option co-ordinator.

Entrepreneurship Option

Course Requirements

The Option requires students to complete six courses. Three of those courses are required, and three are electives.

Required Courses

- BET 100
- BET 320
- BET 340

Electives

- Any other BET courses
- Up to two technical courses in an area related to the milestone requirement, as approved by the option co-ordinator

Entrepreneurial Milestone Requirement

Students can demonstrate entrepreneurial experience through one of:

- Earning credit for an Enterprise Co-op (E Co-op) term.
- Through a capstone design project. Students choosing the capstone design project must participate in the Esch Awards competition, the Hult Prize competition, Concept Grants, Velocity Fund Finals, or an equivalent as approved by the option co-ordinator.
- Developing a new entrepreneurial venture that is not part of the capstone design project for at least a 12-month period, as approved by the option co-ordinator.
- Working for an entrepreneurial venture, including during a co-op term, that is not part of the capstone design project, as approved by the option co-ordinator.

Environmental Engineering Option

The Environmental Engineering Option is not available to Environmental Engineering students.

The Option consists of a set of seven courses chosen from four theme areas, as described below. Substitution of equivalent courses, if applicable, requires the approval of the option co-ordinator.

The courses are (see Note):

- Take two from List A: Environmental Issues and Management
  - ENVE 391 Law and Ethics for Environmental and Geological Engineers
  - ERS 215 Environmental and Sustainability Assessment 1
  - ERS 270 Introduction to Sustainable Agroecosystems
  - ERS 315 Environmental and Sustainability Assessment 2
  - ERS 370 Corporate Sustainability: Issues and Prospects
  - ERS 372 First Nations and the Environment

    - ERS 404 Global Environmental Governance
- Take at least one from List B: Environmental Chemistry and Biology
    - BIOL 150 Organismal and Evolutionary Ecology
    - BIOL 240 Fundamentals of Microbiology
    - BIOL 354 Environmental Toxicology 1
    - BIOL 383 Tropical Ecosystems
    - EARTH 221 Introductory Geochemistry
    - ENVE 275 Environmental Chemistry
    - ENVS 200 Field Ecology
    - HLTH 420 Health, Environment, and Planning
- Take at least two from List C - Environmental and Energy Processes
    - CHE 571 Industrial Ecology
    - CHE 572 Air Pollution Control
    - CHE 574 Industrial Wastewater Pollution Control
    - ENVE 375 Physico-Chemical Processes (or CIVE 375 Environmental Engineering Principles)
    - ENVE 376 Biological Processes
    - ENVE 577 Engineering for Solid Waste Management
    - ME 452 Energy Transfer in Buildings
    - ME 459 Energy Conversion
- Take at least one from List D: Transport, Modelling, and Decision Analysis
    - CIVE 230 Engineering and Sustainable Development
    - EARTH 456 Numerical Methods in Hydrogeology
    - EARTH 458 Physical Hydrogeology
    - ENVE 335 Decision Making for Environmental Engineers
    - ENVE 573 Contaminant Transport
    - ME 571 Air Pollution
    - MSCI 452 Decision Making Under Uncertainty
    - SYDE 532 Introduction to Complex Systems
    - SYDE 533 Conflict Resolution
- Plus one additional course from List B, C, or D above, to total seven courses.

Note
May count towards Complementary Studies Elective (CSE) requirements (check the CSE lists and plan requirements).

International Studies in Engineering Option
The International Studies in Engineering Option will normally require extra academic material on campus, in addition to the overseas experience of work and/or study.

The Option consists of study terms and/or work terms at overseas locations, of at least eight months, together with academic requirements. To be accepted for the International Studies in Engineering Option, the complete package must be approved by the option co-ordinator.

Specific Requirements
There are three specific requirements for a student to complete the Option:

1. **International Experience**: An experience of at least eight months outside of Canada after the completion of term 2B. This may include study terms, work terms, or terms spent as an intern in an academic institution (such as a research laboratory in a university) or with a non-government agency (such as Engineers Without Borders).
2. **Academic Courses**: Six courses approved by the option co-ordinator.
    - No more than three of the courses may be language skills courses.
    - Courses may be taken during normal academic terms, online through the University of Waterloo, or at overseas institutions while the student is on exchange or work term. Language courses given by such organizations as the Goethe Institute may also be included.
    - There is a list of approved University of Waterloo courses for the Option available on the Engineering exchange website. Most courses on the list are also approved as Complementary Studies Electives. Deviation from the list may be approved by the option co-ordinator.
    - Typically, three of the courses should be completed before the international experience, and three afterwards, however, considerable flexibility in timing is allowed.
3. **International Report**: Enrolment in and completion of the requirements for GENE 303. This consists of a report to be written after completion of the international experience component of the

Option. The report may include, but is not restricted to one of the following:

- technical, non-technical, and professional aspects of the foreign residence experience
- socio-economic aspects of life in the foreign country
- a discussion which compares and contrasts conditions in the country or countries involved in the international experience(s)
- a review or analysis of the social or political histories of the country
- trade and commercial relations with or among the country or countries involved

In all cases, the report must include information addressed to the needs of other students considering a similar experience. A general guideline for the report is that it should not be shorter than a co-op work report.

For further information regarding this Option, contact the Faculty of Engineering Exchange Office.

Life Sciences Option

The Faculty of Science provides two options for Engineering students: the Life Sciences Option and the Physical Sciences Option.

The Life Sciences Option has four theme areas: Molecular and Cell Biology, Environmental/Ecological Science, Biophysical Science, and Biochemical Science. Each theme has four required foundations (or core) courses plus three elective courses to be selected from a set of at least seven Faculty of Science courses in the particular theme area. Although this Option is available to all students in the Faculty of Engineering, it is expected to be of particular interest to students in Chemical Engineering, Environmental Engineering, Nanotechnology Engineering, and Systems Design Engineering.

Theme 1: Molecular and Cell Biology

Required courses:

- BIOL 130
- BIOL 239
- BIOL 240
- CHEM 266
- CHEM 262 or NE 222

Electives: choose three

- BIOL 266
- BIOL 308
- BIOL 309
- BIOL 331
- BIOL 342
- BIOL 349
- BIOL 382/AMATH 382
- BIOL 434

Theme 2: Environmental/Ecological Science

Required courses:

- BIOL 239
- BIOL 240
- One of BME 285, CHE 161
- One of BME 186, CHEM 123, CHE 102, NE 121

Electives: choose three

- BIOL 150
- BIOL 241
- BIOL 349
- BIOL 350
- BIOL 351
- BIOL 354
- BIOL 462/EARTH 444

Theme 3: Biophysical Science

Required courses:

- One of BME 186, CHEM 123, CHE 102, NE 121
- PHYS 125 or ECE 105
- PHYS 280/BIOL 280

- PHYS 380

Electives: choose three

- BIOL 349
- One of CHEM 237, CHEM 233, NE 224
- One of CHEM 266, CHEM 262, NE 222
- CHEM 357
- PHYS 395
- PHYS 396

Theme 4: Biochemical Science

Required courses:

- One of BME 285, CHE 161
- One of BME 186, CHEM 123, CHE 102, NE 121
- One of CHEM 266, CHEM 262, NE 222
- CHEM 267

Electives: choose three

- CHEM 220
- One of CHEM 237, CHEM 233, NE 224
- CHEM 333
- CHEM 357
- CHEM 430
- CHEM 432

Notes

1. Students are encouraged to seek information from the option co-ordinator related to combinations of electives and relationships among the courses. Enrolment concerns may need to be discussed with the academic advisor.
2. Some students in the Option may wish to further specialize within a given theme.
3. Students will need to consider the terms of offering for the courses listed as well as the requisite structure. In particular, some courses require both the lecture and the lab component of a course as a prerequisite. It is also important to note that the choices in the earlier courses in the option may impact the elective choices in the senior courses and that some courses require the permission of the instructor.
4. Listed in the electives of some of the themes are special topic courses; a list of the topics available in a given term is available from the department offering the special topics course.

For further information about the Life Sciences Option or one of the theme areas, contact the option co-ordinator.

Management Sciences Option

The Management Sciences Option is not available to Management Engineering students.

Legend

Key	Description
F,W,S	F=fall term, W=winter term, S=spring term
A,B,C,D	These courses count toward Complementary Studies Requirements for Engineering Students: A- Impact, B- Engineering Economics, C- Humanities and Social Sciences, D- Other.
†	These courses may count towards technical elective (or technical breadth elective) requirements. Engineering students should consult the academic advisor in their home department for specific rules that apply to their academic plan.

Requirements

The Option consists of six courses, including two required courses (or their equivalents) and four elective courses (or equivalents).

- The two required courses and equivalents are:
  - MSCI 211[C] Organizational Behaviour (F,W,S) or MSCI 311[C] Organizational Design and Technology (F,W,S); may be replaced by PSYCH 238

- MSCI 331† Introduction to Optimization (F,W,S); may be replaced by BME 411, CHE 521, CIVE 332, CO 250, ENVE 335, or SYDE 411
- Four of the following elective courses or equivalents:
  - MSCI 211C Organizational Behaviour (F,W,S); may be replaced by PSYCH 238
  - MSCI 261B Engineering Economics: Financial Management for Engineers (F,W,S); may be replaced by AE 392, BME 364, CIVE 392, ENVE 392, GEOE 392, or SYDE 262
  - MSCI 263C Managerial Economics (S); may be replaced by ECON 201
  - MSCI 311C Organizational Design and Technology (F,W,S)
  - MSCI 332† Deterministic Optimization Models and Methods (F)
  - MSCI 411C Leadership and Influence (S); may be replaced by BET 450
  - MSCI 422A Economic Impact of Technological Change and Entrepreneurship (F)
  - MSCI 431† Stochastic Models and Methods (W)
  - MSCI 432† Production and Service Operations Management (F,W)
  - MSCI 433† Applications of Management Engineering (W)
  - MSCI 435† Advanced Optimization Techniques (W)
  - MSCI 442A Impact of Information Systems on Organizations and Society (W)
  - MSCI 446† Introduction to Machine Learning (W)
  - MSCI 452† Decision Making Under Uncertainty (S)
  - MSCI 454D Technical Entrepreneurship (W)
  - MSCI 531† Stochastic Processes and Decision Making (S)
  - MSCI 541† Search Engines (F)
  - MSCI 543† Analytics and User Experience
  - MSCI 546† Advanced Machine Learning
  - MSCI 551† Quality Management and Control (F)
  - MSCI 555† Scheduling: Theory and Practice (W)
  - MSCI 597 Complementary Studies Topics in Management Sciences
  - MSCI 598† Special Topics in Management Engineering
  - CIVE 596 Construction Engineering (S)
  - ECON 371 Business Finance 1 (F,W,S)
  - HRM 200C Basic Human Resources Management (F,W,S)
  - SYDE 531† Design Optimization Under Probabilistic Uncertainty (W)
  - SYDE 533 Conflict Resolution (F)

Notes

1. At least three of the six courses must be MSCI courses from the Department of Management Sciences.
2. A maximum of one course from outside the approved list may be counted toward the Option, subject to approval of the option co-ordinator.
3. Students may take both MSCI 211 and MSCI 311, in which case, one will count toward the required courses and the other toward the elective courses.
4. For the designation of Management Sciences Option to be shown on the transcript, the student must achieve a minimum cumulative average of 60% in the six courses.
5. Refer to the University of Waterloo's official Schedule of Classes for confirmation of actual course offerings each term.

For further information about the Management Sciences Option, contact the option co-ordinator in the Management Sciences Department.

Mechatronics Option

Course Requirements

The Option consists of eight courses selected from specified lists plus a design project. Depending on the engineering plan, some of these courses may be part of the core curriculum.

- one from List A: Electronics and Instrumentation
  - BME 294 Circuits, Instrumentation, and Measurements

    - ECE 240 Electronic Circuits 1
    - MTE 220 Sensors and Instrumentation
    - SYDE 292 Circuits, Instrumentation, and Measurements
- on from List B: Embedded Microprocessor Systems
    - ECE 224 Embedded Microprocessor Systems
    - MTE 325 Microprocessor Systems and Interfacing for Mechatronics Engineering
- one from List C: Electromechanical Devices
    - ECE 260 Electromechanical Energy Conversion
    - ME 269 Electromechanical Devices and Power Processing
    - MTE 320 Actuators & Power Electronics
- one from List D: Machine Design
    - ME 321 Kinematics and Dynamics of Machines
    - MTE 321 Design and Dynamics of Machines
- one from List E: Advanced Control Systems
    - ECE 481 Digital Control Systems
    - ECE 484 Digital Control Applications
    - ECE 488 Multivariable Control Systems
    - MTE 460 Mechatronic Systems Integration
- one from List F: Robotics and Automation
    - ECE 486 Robot Dynamics and Control
    - ME 547 Robot Manipulators: Kinematics, Dynamics, Control
    - MTE 544 Autonomous Mobile Robots
- one from List G - Mechanical Systems
    - ME 322 Mechanical Design 1
    - ME 524 Advanced Dynamics and Vibrations
    - SYDE 553 Advanced Dynamics
- one from List H: Elective
    - ECE 356 Database Systems
    - ECE 454 Distributed Computing
    - ECE 455 Embedded Software
    - ECE 457A Co-operative and Adaptive Algorithms
    - ECE 457B Fundamentals of Computational Intelligence
    - ECE 459 Programming for Performance
    - ECE 463 Design & Applications of Power Electronic Converters
    - ME 561 Fluid Power Control Systems
    - SYDE 522 Foundations of Artificial Intelligence
    - SYDE 572 Introduction to Pattern Recognition
    - SYDE 575 Image Processing

Mechatronics Design Project

Each student in the Option must undertake a two-term design project/workshop (BME 461 and BME 462, or ECE 498A and ECE 498B, or ME 481 and ME 482, or SYDE 461 and SYDE 462) with a mechatronics theme which must be approved by the Faculty Mechatronics co-ordinator. Students must also meet the project/workshop requirements of their home department.

Notes

1. The courses listed above may have prerequisites, and it is the student's responsibility to satisfy these requirements or otherwise obtain permission to enrol.
2. Students are encouraged to contact the option co-ordinator if they have difficulty enrolling in a course. The Mechatronics Option is not available to the Mechatronics Engineering students.

Physical Sciences Option

The Faculty of Science provides access to two options for Engineering students: the Life Sciences Option and the Physical Sciences Option.

The Physical Sciences Option has three theme: Physics, Chemistry, and Earth and Environmental Sciences. Each theme has four required foundations (or core) courses plus three elective courses to be chosen from a set of at least 10 Faculty of Science courses in the theme area. Sub-themes may be followed by making judicious choices of three elective courses. This Option is available to all students in the Faculty of Engineering.

Theme 1: Physics

Required courses:

- One of PHYS 115, PHYS 121, ECE 105, NE 131
- One of PHYS 122, PHYS 125, ECE 106, NE 241, SYDE 283
- PHYS 234 or NE 332
- One of ECE 140, PHYS 242, PHYS 263, PHYS 334, PHYS 358

Electives: choose three

- PHYS 275
- PHYS 334
- PHYS 335
- PHYS 342
- PHYS 359 or NE 334
- PHYS 364
- PHYS 365
- PHYS 375
- PHYS 434
- PHYS 435
- PHYS 442
- PHYS 454
- PHYS 467
- PHYS 475

Subthemes

Electromagnetic Theory

- PHYS 342
- PHYS 364
- PHYS 365

Solid State Physics

- PHYS 334
- PHYS 335
- PHYS 358
- PHYS 359

Astrophysics

- PHYS 263
- PHYS 275
- PHYS 375
- PHYS 475

Quantum Physics

- PHYS 334
- PHYS 364
- PHYS 365
- PHYS 434

Theme 2: Chemistry

Required courses:

- One of CHEM 123, CHE 102, NE 121
- CHEM 209
- CHEM 212 or NE 225

- One of CHEM 264, CHEM 262, NE 222

Electives: choose three

- CHEM 220
- CHEM 221
- One of CHEM 254, CHE 230, ME 250, SYDE 381
- CHEM 265
- CHEM 310
- CHEM 313
- CHEM 323
- CHEM 340
- CHEM 350
- One of CHEM 356, NE 332, PHYS 234
- CHEM 360
- CHEM 370 or NE 333

Subthemes

Analytical Chemistry

- CHEM 220
- CHEM 221
- CHEM 323

Inorganic Chemistry

- CHEM 212
- CHEM 310
- CHEM 313

Organic Chemistry

- One of CHEM 264, CHEM 262, NE 222
- CHEM 265
- CHEM 360

Physical Chemistry

- CHEM 254
- CHEM 350
- CHEM 356

Theme 3: Earth and Environmental Sciences

Required courses:

- One of CHEM 123, CHE 102, NE 121
- One of PHYS 121, ECE 105, NE 131, PHYS 115
- One of PHYS 122, ECE 106, PHYS 125
- One of CIVE 153/ENVE 153, EARTH 121 and EARTH 121L, EARTH 122 and EARTH 122L

Electives: choose three

- EARTH 221
- EARTH 231
- EARTH 232
- EARTH 235
- EARTH 260
- EARTH 270
- EARTH 281
- EARTH 333

- EARTH 358
- EARTH 421
- EARTH 438
- EARTH 440
- EARTH 444
- EARTH 456
- EARTH 458
- EARTH 459
- EARTH 460
- EARTH 471

Subthemes

Environmental Science

- EARTH 270
- EARTH 281
- EARTH 444

Geology

- EARTH 232
- EARTH 333
- EARTH 471

Geochemistry

- EARTH 221
- EARTH 421
- EARTH 459

Geophysics

- EARTH 260
- EARTH 438
- EARTH 460

Hydrogeology

- EARTH 456
- EARTH 458

Notes

1. Students are encouraged to seek information from the co-ordinator related to combinations of electives and relationships among the courses. Enrolment concerns may need to be discussed with the academic advisor.
2. Some students in the Option may wish to further specialize within a given theme. As a result, a number of sub-themes have been identified and this information is available from the option theme co-ordinator.
3. Students will need to consider the terms of offering for the courses listed as well as the requisite structure. In particular, some courses require both a lecture and lab component of a course as a prerequisite. It is also important to note that the choices in the earlier courses in the option may impact the elective choices in the senior courses and that some courses require the permission of the instructor.

4. Listed in the electives of some of the themes are special topic courses; a list of the topics available in a given term is available from the department offering the special topics course.
5. Due to the overlap, the Earth and Environmental Sciences theme is not available to Geological Engineering students.

Software Engineering Option

The Software Engineering Option is available to all students in the Faculty of Engineering (including Architecture), except students in Software Engineering.

This Option is offered jointly by the Faculty of Engineering and the David R. Cheriton School of Computer Science in the Faculty of Mathematics.

For students in the Faculty of Engineering, this Option requires a total of eight courses.

- Three required courses:
  - CS 445/ECE 451 or SE 463 Software Requirements Specification and Analysis
  - CS 446/ECE 452 or SE 464 Software Design and Architectures
  - CS 447/ECE 453 or SE 465 Software Testing, Quality Assurance and Maintenance, or Software Testing and Quality Assurance
- Four additional courses from the topics list below, one of which may be substituted with a course from the data structures and algorithms list.
- One course from List A Complementary Studies Electives for Engineering Students that considers application of computing technology, or an alternative approved by the option co-ordinator.

The courses chosen to satisfy this Option must satisfy four additional constraints:

- They must satisfy Canadian Engineering Accreditation Board (CEAB) requirements.
- They must be approved by the option co-ordinator.
- Five of the courses must be considered elective (that is, not core requirements) in the student's academic plan. For the purposes of this Option, a course that a student could choose to graduate without will be considered elective.
- The student must have earned a minimum average of 75% in the selected courses in order to have earned the Option.

Students may not declare this Option until they have completed both an introductory programming course and a data structures and algorithms course. Students must have a minimum average of 75% in these two courses in order to declare this Option.

The lists below are intended to be the same as for the Computing Option and the Computer Engineering Option. These lists are also intended to include courses that are normally part of the Computing Minor offered by the Cheriton School of Computer Science. Other courses from Computer Science may be used towards this Option with permission of the option co-ordinator. Students may declare at most one of the Computing Option, Computer Engineering Option, or Software Engineering Option. Students may change which of the three Options they declare by contacting the option co-ordinator(s).

Introductory Programming

- AE 121 Computational Methods
- BME 121 Digital Computation
- CHE 120 Computer Literacy and Programming for Chemical Engineers
- CIVE 121 Computational Methods
- CS 115 Introduction to Computer Science 1
- CS 116 Introduction to Computer Science 2
- CS 135 Designing Functional Programs
- CS 145 Designing Functional Programs (Advanced Level)
- ECE 150 Fundamentals of Programming
- ENVE 121 Computational Methods
- GEOE 121 Computational Methods
- ME 101 Introduction to Mechanical Engineering Practice 2
- MSCI 121 Introduction to Computer Programming
- MTE 121 Digital Computation
- NE 111 Introduction to Programming for Engineers
- SYDE 121 Digital Computation

Data Structures and Algorithms

- BME 122 Data Structures and Algorithms

- CS 136 Elementary Algorithm Design and Data Abstraction and CS 136L Tools and Techniques for Software Development (see Note)
- CS 146 Elementary Algorithm Design and Data Abstraction (Advanced Level) and CS 136L Tools and Techniques for Software Development (see Note)
- CS 231 Algorithmic Problem Solving
- CS 234 Data Types and Structures
- ECE 250 Algorithms and Data Structures
- ECE 406 Algorithm Design and Analysis
- MSCI 240 Algorithms and Data Structures
- MTE 140 Algorithms and Data Structures
- SYDE 223 Data Structures and Algorithms

Note: Students who take CS 136 or CS 146 will also be required to enrol in CS 136L which is graded CR/NCR basis. However, passing CS 136L is not a requirement for the option and the course may be coded as NRNA.

Topics List

The following list of topics are organized into specific areas for readability.

Logic

- CS 245 Logic and Computation
- ECE 208 Discrete Mathematics and Logic 2
- SE 212 Logic and Computation

Databases

- CS 338 Computer Applications in Business: Databases
- ECE 356 Database Systems
- MSCI 245 Databases and Software Design

Operating Systems

- ECE 350 Real-Time Operating Systems
- MTE 241 Introduction to Computer Structures & Real-Time Systems
- SE 350 Operating Systems

Computing Systems

- ECE 252 Systems Programming and Concurrency
- ECE 351 Compilers
- ECE 454 Distributed Computing
- ECE 455 Embedded Software
- ECE 459 Programming for Performance

Networks

- ECE 358 Computer Networks

Digital Hardware

- BME 393 Digital Systems
- CS 230 Introduction to Computers and Computer Systems
- ECE 124 Digital Circuits and Systems
- ECE 222 Digital Computers
- ECE 224 Embedded Microprocessor Systems
- ECE 320 Computer Architecture
- ECE 327 Digital Hardware Systems
- ECE 423 Embedded Computer Systems
- ME 262 Introduction to Microprocessors and Digital Logic
- MTE 262 Introduction to Microprocessors and Digital Logic
- MTE 325 Microprocessor Systems and Interfacing for Mechatronics Engineering
- SYDE 192 Digital Systems

Software Engineering

- CS 445/ECE 451 Software Requirements Specification and Analysis
- CS 446/ECE 452 Software Design and Architectures
- CS 447/ECE 453 Software Testing, Quality Assurance and Maintenance
- MSCI 342 Principles of Software Engineering
- SE 463 Software Requirements Specification and Analysis

- SE 464 Software Design and Architectures
- SE 465 Software Testing and Quality Assurance

Human-Computer Interaction

- MSCI 343 Human-Computer Interaction
- MSCI 541 Search Engines
- MSCI 543 Analytics and User Experience
- SYDE 542 Interface Design
- SYDE 543 Cognitive Ergonomics
- SYDE 548 User Centred Design Methods

Security and Privacy

- ECE 409 Cryptography and System Security
- ECE 458 Computer Security

Pattern Analysis and Machine Intelligence

- ECE 417 Image Processing
- ECE 457A Co-operative and Adaptive Algorithms
- ECE 457B Fundamentals of Computational Intelligence
- ECE 457C Reinforcement Learning
- MSCI 436 Decision Support Systems
- MSCI 446 Introduction to Machine Learning
- MSCI 546 Advanced Machine Learning
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 552 Computational Neuroscience
- SYDE 556 Simulating Neurobiological Systems
- SYDE 572 Introduction to Pattern Recognition
- SYDE 575 Image Processing

Numerical Methods

- BME 411 Optimization and Numerical Methods
- CHE 322 Numerical Methods for Process Analysis and Design
- CIVE 422 Finite Element Analysis
- EARTH 456 Numerical Methods in Hydrogeology
- ECE 204 Numerical Methods
- ECE 204A Numerical Methods 1 and ECE 204B Numerical Methods 2
- ENVE 225 Environmental Modelling
- ME 559 Finite Element Methods
- ME 566 Computational Fluid Dynamics for Engineering Design
- MTE 204 Numerical Methods
- NE 336 Micro and Nanosystem Computer-aided Design
- SYDE 411 Optimization and Numerical Methods

Special topics courses as approved by the option co-ordinator.

Statistics Option

- Four required courses:
  - STAT 231 Statistics (or equivalent, e.g., CHE 220, CIVE 224, ENVE 224, ME 202, MSCI 251, MTE 201, NE 215, SYDE 212)
  - STAT 331 Applied Linear Models (or equivalent, e.g., SYDE 334)
  - STAT 332 Sampling and Experimental Design (or equivalent, e.g., MSCI 253)
  - STAT 435 Statistical Methods for Process Improvements
- Three courses from those listed below:
  - CHE 225 Strategies for Process Improvement and Product Development
  - CHE 341 Introduction to Process Control
  - CHE 522 Advanced Process Dynamics and Control
  - CHE 524 Process Control Laboratory
  - CIVE 343 Traffic Simulation Modelling and Applications
  - CIVE 375 Environmental Engineering Principles
  - CIVE 440 Transit Planning and Operations
  - ENVE 573 Contaminant Transport
  - ME 340 Manufacturing Processes

- MSCI 431 Stochastic Models and Methods or SYDE 531 Design Optimization Under Probabilistic Uncertainty
- MSCI 432 Production and Service Operations Management
- MSCI 452 Decision Making Under Uncertainty
- STAT 230 Probability (or equivalent)
- STAT 333 Stochastic Processes 1
- STAT 430 Experimental Design
- STAT 431 Generalized Linear Models and their Applications
- STAT 433 Stochastic Processes 2
- STAT 443 Forecasting
- SYDE 533 Conflict Resolution
- SYDE 572 Introduction to Pattern Recognition

For further information, contact the option co-ordinator.

Accelerated Master's Programs

Undergraduate students in the Faculty of Engineering may be allowed to complete some of the work required for the completion of the Master of Applied Science (MASc) degree. Students will take graduate courses during their fourth year and may also begin work on their thesis topic thereby facilitating the timely and possibly early completion of the Master's degree. Admission to an Accelerated Master's program will normally take place in the 3A/3B level, with the approval of the department undergraduate and graduate officers.

Students interested in this opportunity should contact the co-ordinator of undergraduate or graduate studies in their department for more information. Also, see the Accelerated Master's web page.

Architectural Engineering

The Architectural Engineering Academic Curriculum

A total of two approved Complementary Studies Electives (CSE), in addition to ENGL 191/SPCOM 191, AE 101, AE 392, and AE 491, and eight approved Technical Electives (TE) must be completed as detailed in the following sections.

Term 1A (Fall)

- AE 100 Concepts Studio
- AE 101 History of the Built Environment (List C-Humanities and Social Sciences CSE)
- AE 104 Mechanics 1
- AE 115 Linear Algebra
- CHE 102 Chemistry for Engineers
- MATH 116 Calculus 1 for Engineering

Term 1B (Spring)

- AE 105 Mechanics 2
- AE 121 Computational Methods
- AE 123 Electrical Circuits and Instrumentation
- AE 125 Structural Design Studio
- AE 199 Seminar
- MATH 118 Calculus 2 for Engineering

Term 2A (Winter)

- AE 200 Enclosure Design Studio
- AE 204 Solid Mechanics 1
- AE 221 Advanced Calculus
- AE 224 Probability and Statistics
- AE 280 Fluid Mechanics and Thermal Sciences
- AE 298 Seminar
- ENGL 191/SPCOM 191 Communication in the Engineering Profession (List D-Other CSE)

Term 2B (Fall)

- AE 205 Solid Mechanics 2
- AE 223 Differential Equations and Balance Laws
- AE 225 Environmental Building Systems Studio
- AE 265 Structure and Properties of Materials

- AE 299 Seminar
- CSE 3 or TE 1 Approved Complementary Studies Elective or Technical Elective
- WKRPT 200 Work-term Report

Term 3A (Spring)

- AE 279 Energy and the Environment
- AE 300 Architectural Engineering Studio
- AE 303 Structural Analysis
- AE 353 Soil Mechanics and Foundations
- AE 377 Structural Timber Design
- AE 398 Seminar
- WKRPT 300 Work-term Report

Term 3B (Winter)

- AE 310 Introduction to Structural Design
- AE 325 Project 1 Studio
- AE 392 Economics and Life Cycle Analysis (List B-Engineering Economics CSE)
- AE 399 Seminar
- CIVE 507 Building Science and Technology
- CSE 3 or TE 1 Approved Complementary Studies Elective or Technical Elective
- WKRPT 400 Work-term Report

Note: Elective must be a Technical Elective (TE) if Complementary Studies Elective (CSE) is selected in a previous term, and vice versa.

Term 4A (Spring)

- AE 400 Project 2 Studio
- AE 491 Engineering Law and Ethics (List D-Other CSE)
- AE 498 Seminar
- TE 2 Approved Technical Elective
- TE 3 Approved Technical Elective
- TE 4 Approved Technical Elective

Term 4B (Winter)

- AE 425 Project 3 Studio
- AE 499 Seminar
- CSE 6 Approved Complementary Studies Elective
- TE 5 Approved Technical Elective
- TE 6 Approved Technical Elective
- TE 7 Approved Technical Elective
- TE 8 Approved Technical Elective

Electives

Students are responsible for selecting their own combination of electives, in keeping with their ultimate career objectives after graduation. The combination must satisfy the requirements of the Department of Civil and Environmental Engineering (CEE). This includes having to meet minimum requirements in mathematics, natural sciences, engineering sciences, engineering design, and complementary studies.

Exceptions to the elective courses and requirements listed in the following sections (and links) require approval of the CEE Department. Some courses of interest may require prerequisite knowledge that is not part of the core curriculum in Architectural Engineering. Students may require extra courses or may need to seek enrolment approval from the course instructor if the prerequisites have not been satisfied.

Complementary Studies Electives

All Engineering students are required to take complementary studies courses, as described in Complementary Studies Requirements for Engineering Students. Two Complementary Studies Elective (CSE) courses must be taken in approved non-technical subjects. The CSEs are in addition to those courses which are part of the core curriculum and contain complementary studies material, such as ENGL 191/SPCOM 191 (List D), AE 101 (List C), AE 392 (List B), and AE 491 (List D). The two CSE courses are to be chosen according to the following constraints:

- One course from List A - Impact Courses

- One course from List C - Humanities and Social Sciences Courses

Technical Electives
Students are required to complete eight technical elective (TE) courses within the following requirements:

1. At least three TEs must be from TE List A (Architectural Engineering Technical Electives)
2. At least two TEs must be from TE List B (Engineering Design Intensive Technical Electives)
3. One TE must be from TE List D (Natural Science Technical Electives)

The Technical Elective lists for Architectural Engineering are provided below. Note that the offering of these courses is contingent upon sufficient demand and/or available teaching resources. There may be courses added and changes made to the content, term of offering, or meet times from what is listed below. Special Topics Courses (AE 495 and AE 497) are offered as resources and faculty availability permit. Further information is available from the CEE Undergraduate Office or CEE website.

Legend for TE List A, B, C, and D

Term courses are offered: F=fall term, W=winter term, S=spring term

TE List A - Architectural Engineering Technical Electives

Choose at least three

- AE 301 Building Enclosure Systems (W)
- AE 315 Building Structural Systems (W)
- AE 405 Building Performance Measurement Lab (S)
- AE 450 Building Service Systems (S)
- AE 495 Design Intensive Special Topics in Architectural Engineering (as offered)
- AE 572 Building Energy Analysis (F,S)
- AE 573 HVAC Systems, Equipment, and Energy Efficiency (W)
- ARCH 570 Special Topics in Building Technology and Environmental (F,W,S)
- ME 452 HVAC Load Analysis and Design Fundamentals (W)

TE List B - Engineering Design Intensive Technical Electives

Choose at least two

- ARCH 463 Integrated Environmental Systems (S)
- CIVE 413 Structural Steel Design (S)
- CIVE 414 Structural Concrete Design (S)
- CIVE 415 Structural System Design (W)
- CIVE 460 Engineering Biomechanics (W)
- CIVE 495 Design Intensive Special Topics in Civil Engineering (as offered)
- CIVE 512 Rehabilitation of Structures (W)
- CIVE 596 Construction Engineering (S)

TE List C - Engineering Technical Electives

- AE 497 Special Topics in Architectural Engineering (as offered)
- CIVE 422 Finite Element Analysis (W)
- CIVE 484 Physical Infrastructure Planning (S)
- CIVE 497 Special Topics in Civil Engineering (as offered)
- CIVE 505 Structural Dynamics (S)

List D - Natural Science Technical Electives

Choose one

- BIOL 130 Introductory Cell Biology (F,W)
- BIOL 150 Organismal and Evolutionary Ecology (F)
- BIOL 240 Fundamentals of Microbiology (F,W,S)
- BIOL 273 Principles of Human Physiology 1 (F,W, and online S)
- CHE 161 Engineering Biology (W,S)
- CHEM 209 Introductory Spectroscopy and Structure (F)
- CHEM 262 Organic Chemistry for Engineering (F,W)
- EARTH 221 Introductory Geochemistry (W,S)
- EARTH 270 Disasters and Natural Hazards (W)
- EARTH 281 Geological Impacts on Human Health (W)
- ENVS 200 Field Ecology (F,W,S)
- KIN 100 Regional Human Anatomy and KIN 100L Regional Human Anatomy Laboratory (W)
- SCI 207 Physics, the Universe, and Everything (W)
- SCI 238 Introductory Astronomy (F,W,S)

Specializations

The Faculty of Engineering recognizes two specializations with the Architectural Engineering BASc degree. Students who satisfy the specialization requirements (courses and grades) will have the specialization designation shown on their transcript and diploma. Specializations are intended to recognize success in a concentration of electives within the Architectural Engineering degree specification. In other words, specializations focus the selection of electives required for the base degree and do not require extra courses.

Each specialization requires students to select technical electives with a common theme. Students are responsible for meeting the TE requirements of the Architectural Engineering degree when pursuing a specialization. Each specialization requires the successful completion of a minimum number of TEs specified by the specialization with a minimum average of 60%. Students must declare a specialization for it to be recognized as part of their degree and appear on the transcript and diploma.

The specialization course requirements are provided below. Exceptions to the listed courses require the approval of the CEE Department.

Building Structures Specialization

The Building Structures Specialization requires a minimum of five TEs from the list below, of which one must be CIVE 413 or CIVE 414.

- From TE List A:
  - AE 315 Building Structural Systems (W)
- From TE List B:
  - CIVE 413 Structural Steel Design (S)
  - CIVE 414 Structural Concrete Design (S)
  - CIVE 415 Structural System Design (W)
  - CIVE 460 Engineering Biomechanics (W)
  - CIVE 512 Rehabilitation of Structures (W)
  - CIVE 596 Construction Engineering (S)
- From TE List C:
  - CIVE 422 Finite Element Analysis (W)
  - CIVE 505 Structural Dynamics (S)

Building Systems Specialization

The Building Systems Specialization requires a minimum of four TEs from the list below (all are from TE List A).

- AE 301 Building Enclosure Systems (W)
- AE 315 Building Structural Systems (W)
- AE 405 Building Performance Measurement Lab (S)
- AE 450 Building Service Systems (S)
- AE 572 Building Energy Analysis (F,S)
- AE 573 HVAC Systems, Equipment, and Energy Efficiency (W)
- ME 452 HVAC Load Analysis and Design Fundamentals (W)

Biomedical Engineering

The Biomedical Engineering Academic Curriculum

The Biomedical Engineering curriculum consists of two course groupings:

1. Compulsory core courses that prepare the student for practice in engineering and comprise 70% to 80% of the course load.
2. Elective courses that comprise 20% to 30% of the course load.

The following is the current core course curriculum with the course weight shown in square brackets [ ] next to each course.

Term 1A (Fall)

- BME 101 [0.25] Communications in Biomedical Engineering-Written and Oral (2 LEC,1 TUT)
- BME 101L [0.25] Communications in Biomedical Engineering-Visualization (1 LEC,3 LAB)
- BME 121 [0.50] Digital Computation (3 LEC,1 TUT,3 LAB)
- BME 161 [0.50] Introduction to Biomedical Design (3 LEC,1 TUT)
- BME 181 [0.50] Physics 1 - Statics (3 LEC,1 TUT)
- SYDE 111 [0.50] Calculus 1 (3 LEC,3 TUT)
- SYDE 113 [0.25] Elementary Engineering Math (2 LEC,2 TUT)

Term 1B (Winter)

- BME 102 [0.00] Seminar (1 SEM)
- BME 122 [0.50] Data Structures and Algorithms (3 LEC,1 TUT)
- BME 162 [0.50] Human Factors in the Design of Biomedical and Health Systems (3 LEC,1 TUT)
- BME 186 [0.50] Chemistry Principles (3 LEC,1 TUT)
- SYDE 112 [0.50] Calculus 2 (3 LEC,2 TUT)
- SYDE 114 [0.25] Matrices and Linear Systems (2 LEC,2 TUT)
- One Complementary Studies Elective

Term 2A (Fall)

- BME 201 [0.00] Seminar (1 SEM)
- BME 182 [0.50] Physics 2 - Dynamics (3 LEC,1 TUT)
- BME 281 [0.50] Mechanics of Deformable Solids (3 LEC,1 TUT)
- BME 281L [0.25] Mechanics of Deformable Solids Laboratory (3 LAB)
- BME 282 [0.50] Materials Science for Biomedical Engineers (3 LEC,1 TUT)
- BME 285 [0.50] Engineering Biology (3 LEC,1 TUT)
- BME 285L [0.25] Engineering Biology Laboratory (3 LAB)
- SYDE 211 [0.50] Calculus 3 (3 LEC,1 TUT)

Term 2B (Spring)

- BME 202 [0.00] Seminar (1 SEM)
- BME 213 [0.50] Statistics and Experimental Design (3 LEC,1 TUT)
- BME 252 [0.50] Linear Signals and Systems (3 LEC,1 TUT)
- BME 261 [0.50] Prototyping, Simulation and Design (3 LEC,1 TUT)
- BME 284 [0.50] Physiological and Biological Systems (3 LEC,1 TUT)
- BME 284L [0.25] Physiology and Anatomy Laboratory (3 LAB)
- BME 294 [0.50] Circuits, Instrumentation, and Measurements (3 LEC,1 TUT)
- BME 294L [0.25] Circuits, Instrumentation, and Measurements Laboratory (3 LAB)
- WKRPT 200 [0.13] Work-term Report

Term 3A (Winter)

- BME 301 [0.00] Seminar (1 SEM)
- BME 355 [0.50] Physiological Systems Modelling (3 LEC,1 TUT)
- BME 361 [0.50] Biomedical Engineering Design (3 LEC,1 TUT,3 LAB)
- BME 381 [0.50] Biomedical Engineering Ethics (3 LEC,1 TUT)
- BME 393 [0.50] Digital Systems (3 LEC,1 TUT)
- BME 393L [0.25] Digital Systems Laboratory (3 LAB)
- WKRPT 300 [0.13] Work-term Report
- One Technical Elective or One Complementary Studies Elective

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Term 3B (Fall)

- BME 302 [0.00] Seminar (1 SEM)
- BME 356 [0.50] Control Systems (3 LEC,1 TUT)
- BME 356L [0.25] Control Systems Laboratory (3 LAB)

- BME 362 [0.50] Biomedical Engineering Design Workshop 1 (2 LEC,3 LAB)
- BME 364 [0.50] Engineering Biomedical Economics (3 LEC,1 TUT)
- BME 384 [0.50] Biomedical Transport: Biofluids and Mass Transfer (3 LEC,1 TUT)
- BME 386 [0.50] The Physics of Medical Imaging (3 LEC,1 TUT)

Term 4A (Fall)

- BME 401 [0.00] Seminar (1 SEM)
- BME 411 [0.50] Optimization and Numerical Methods (3 LEC,1 TUT)
- BME 461 [0.50] Biomedical Engineering Design Workshop 2 (2 LEC,3 LAB)
- WKRPT 400 [0.13] Work-term Report
- One Complementary Studies Elective
- Two Technical Electives

Term 4B (Winter)

- BME 402 [0.00] Seminar (1 SEM)
- BME 462 [0.50] Biomedical Engineering Design Workshop 3 (1 LEC,3 LAB)
- One Complementary Studies Elective
- Three Technical Electives

CEAB Requirements

Elective course selections must meet CEAB requirements, including a minimum number of instruction hours in the various CEAB categories. To determine the suitability of elective courses, students should complete the CEAB planner. In addition to meeting CEAB requirements, the student's course selections (as reported in their planner) should be logical and defensible. Two planners must be completed and submitted to the director of biomedical engineering, one planner for approval purposes in the student's 3A term, and one planner for graduation purposes at the end of the student's 4A term.

Students that have combinations of electives that result in a plan that does not meet CEAB criteria will not be permitted to graduate.

Complementary Studies Electives

In addition to the two courses in the core curriculum (BME 364 and BME 381), at least three elective courses must be chosen to satisfy the Complementary Studies Requirements for Engineering Students. Only courses noted in Lists A, B, C, and D are Faculty-approved complementary studies elective courses. Students may arrange the sequencing of the complementary studies elective courses to suit their academic plan (and any course prerequisites).

Technical Electives

Each student in Biomedical Engineering must complete at least six approved technical electives (TEs) to meet graduation requirements. Students may arrange the sequencing of the technical elective courses to suit their plan (and any course prerequisites).

The Department of Systems Design Engineering offers a wide variety of technical elective courses in the third and fourth year. Biomedical Engineering students are encouraged to design their own elective package to develop expertise in their particular interest area. Approved technical elective courses are available from the Department of Systems Design Engineering (SYDE and BME TEs), from other Engineering departments, and from a wide list of technical courses in the faculties of Science and Mathematics. There are a variety of technical electives with biomedical content, but students can also take technical electives on other topics. Only courses from Engineering and Computer Science will contribute towards CEAB hours in the categories of "Engineering Science" and "Engineering Design." Some examples are listed below.

Biomedical Engineering

- BME 499 Elective Biomedical Research Project
- BME 550 Sports Engineering
- BME 551 Biomechanics of Human Movement
- BME 581 Ultrasound in Medicine and Biology
- BME 587 Special Topics in Biomedical Signals
- BME 588 Special Topics in Biomechanics
- BME 589 Special Topics in Biomedical Devices

Civil Engineering

- CIVE 460 Engineering Biomechanics

Electrical and Computer Engineering

- ECE 224 Embedded Microprocessor Systems
- ECE 252 Systems Programming and Concurrency
- ECE 254 Operating Systems and Systems Programming
- ECE 356 Database Systems
- ECE 358 Computer Networks
- ECE 406 Algorithm Design and Analysis
- ECE 457B Fundamentals of Computational Intelligence
- ECE 459 Programming for Performance
- ECE 484 Digital Control Applications

Management Sciences

- MSCI 343 Human-Computer Interaction
- MSCI 432 Production and Service Operations Management
- MSCI 446 Introduction to Machine Learning
- MSCI 555 Scheduling: Theory and Practice

Mechanical Engineering

- ME 574 Engineering Biomechanics

Mechatronics Engineering

- MTE 241 Introduction to Computer Structures & Real-Time Systems
- MTE 325 Microprocessor Systems and Interfacing for Mechatronics Engineering
- MTE 544 Autonomous Mobile Robots

Systems Design Engineering

- SYDE 322 Software Design
- SYDE 334 Applied Statistics
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 531 Design Optimization Under Probabilistic Uncertainty
- SYDE 532 Introduction to Complex Systems
- SYDE 533 Conflict Resolution
- SYDE 542 Interface Design
- SYDE 543 Cognitive Ergonomics
- SYDE 544 Biomedical Measurement and Signal Processing
- SYDE 548 User Centred Design Methods
- SYDE 552 Computational Neuroscience
- SYDE 553 Advanced Dynamics
- SYDE 556 Simulating Neurobiological Systems
- SYDE 572 Introduction to Pattern Recognition
- SYDE 575 Image Processing
- SYDE 584 Physiological Systems and Biomedical Design
- SYDE 599 Special Topics in Systems Design Engineering

Specializations

Students may choose to take their technical electives from a more restricted list to receive the Neural Engineering Specialization or the Sports Engineering Specialization.

Neural Engineering Specialization

The Neural Engineering Specialization consists of seven courses covering a wide range of neuroscience topics and computational applications in neuroscience. Students are also required to do their capstone design project (BME 461 or GENE 403 or SYDE 461 and BME 462 or GENE 404 or SYDE 462) with a focus on neuroscience applications. The project must be approved by the co-ordinator of the Neural Engineering Specialization. A minimum average of 60% in the seven specialization courses and a grade of at least 50% in each of the courses is required. Students who satisfy the requirements for Options, Specializations and Electives for Engineering Students will have the appropriate designation shown on their diploma and transcript.

Required courses:

- BME 461 Biomedical Engineering Design Workshop 2, or GENE 403 Interdisciplinary Design Project 1, or SYDE 461 Systems Design Capstone Project 1
- BME 462 Biomedical Engineering Design Workshop 3, or GENE 404 Interdisciplinary Design Project 2, or SYDE 462 Systems Design Capstone Project 2

- SYDE 552 Computational Neuroscience, or SYDE 556 Simulating Neurobiological Systems

Two courses from List A: Anatomy and Physiology of the Nervous System):

- BIOL 376 Cellular Neurophysiology (offered fall for odd years)
- KIN 255 Fundamentals of Neuroscience
- KIN 301 Human Anatomy of the Central Nervous System
- KIN 416 Neuromuscular Integration
- PHIL 256/PSYCH 256 Introduction to Cognitive Science
- PSYCH 261 Physiological Psychology
- PSYCH 307 Human Neuropsychology

One course from List B: Computational Applications in Neuroscience):

- AMATH 451 Introduction to Dynamical Systems
- AMATH 382/BIOL 382 Computational Modelling of Cellular Systems
- BME 499 Elective Biomedical Research Project (requires approval from the co-ordinator of the Neural Engineering Specialization)
- BME 587 Special Topics in Biomedical Signals (requires approval from the co-ordinator of the Neural Engineering Specialization)
- STAT 441 Statistical Learning - Classification
- STAT 444 Statistical Learning - Advanced Regression
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 552 Computational Neuroscience
- SYDE 556 Simulating Neurobiological Systems
- SYDE 572 Introduction to Pattern Recognition

One additional course from either List A or List B.

Notes

1. It is the student's responsibility to ensure that their course selection meets the Biomedical Engineering requirements as well as the CEAB requirements, which include a minimum number of instruction hours in the various CEAB categories. Some courses in List A (PHIL 256/PSYCH 256 and PSYCH 307) can be counted towards Complementary Studies Requirements.
2. Biomedical Engineering students may lack prerequisites for some of these courses and should ensure that they obtain the prerequisite courses prior to taking such courses. However, there are several courses in the list (BIOL 376, PHIL 256/PSYCH 256, SYDE 522, SYDE 552, SYDE 556, and SYDE 572) where students will have the appropriate prerequisites.

Sports Engineering Specialization

The Sports Engineering Specialization consists of two specific required TE courses, which provide the necessary background on the musculoskeletal dynamics and optimal performance of athletes as well as sports equipment design, training devices, and their interaction with the athlete, plus three additional courses drawn from the provided list. Students are also required to do their capstone design project (BME 461 or GENE 403 or SYDE 461 and BME 462 or GENE 404 or SYDE 462) with a focus on the design of a new sport equipment or training device. The project must be approved by the co-ordinator of the Sports Engineering Specialization. A minimum average of 60% in the seven specialization courses and a grade of at least 50% in each of the courses is required. Students who satisfy the requirements for Options, Specializations and Electives for Engineering Students will have the appropriate designation shown on their diploma and transcript.

Required courses:

- BME 461 Biomedical Engineering Design Workshop 2, or GENE 403 Interdisciplinary Design Project 1, or SYDE 461 Systems Design Capstone Project 1
- BME 462 Biomedical Engineering Design Workshop 3, or GENE 404 Interdisciplinary Design Project 2, or SYDE 462 Systems Design Capstone Project 2
- BME 550 Sports Engineering
- BME 551 Biomechanics of Human Movement

Any three courses from the following list must also be taken:

- BME 499 Elective Biomedical Research Project (requires approval from the co-ordinator of the Sports Engineering Specialization)

- BME 588 Special Topics in Biomechanics
- CIVE 460 Engineering Biomechanics
- ECE 417 or SYDE 575 Image Processing
- KIN 340 Musculoskeletal Injuries in Sport and Activity
- ME 362 Fluid Mechanics 2
- ME 533 Non-metallic and Composite Materials
- ME 559 Finite Element Methods
- SYDE 544 Biomedical Measurement and Signal Processing
- SYDE 553 Advanced Dynamics

Note
It is the student's responsibility to ensure that their course selection meets the Biomedical Engineering requirements as well as the CEAB requirements, which include a minimum number of instruction hours in the various CEAB categories.

Chemical Engineering

The Chemical Engineering Academic Curriculum

Term 1A (Fall)

- CHE 100 Chemical Engineering Concepts 1 (3 LEC,2 TUT)
- CHE 102 Chemistry for Engineers (3 LEC,2 TUT)
- CHE 120 Computer Literacy and Programming for Chemical Engineers (2 LEC,2 LAB)
- CHE 180 Chemical Engineering Design Studio 1 (1 LEC,2 STU,1 SEM)
- MATH 115 Linear Algebra for Engineering (3 LEC,2 TUT)
- MATH 116 Calculus 1 for Engineering (3 LEC,2 TUT)

Term 1B (Winter Stream 8D/Spring Stream 4D)

- CHE 101 Chemical Engineering Concepts 2 (3 LEC,2 TUT,2 LAB)
- CHE 161 Engineering Biology (3 LEC,1 TUT)
- CHE 181 Chemical Engineering Design Studio 2 (2 LEC,2 STU,1 SEM)
- MATH 118 Calculus 2 for Engineering (3 LEC,2 TUT)
- PHYS 115 Mechanics (3 LEC,2 TUT)
- Undergraduate Communication Requirement course

Term 2A (Fall Stream 8D/Winter Stream 4D)

- CHE 200 Equilibrium Stage Operations (3 LEC,1 TUT)
- CHE 220 Process Data Analysis (3 LEC,1 TUT)
- CHE 230 Physical Chemistry 1 (3 LEC,1 TUT)
- CHE 290 Chemical Engineering Lab 1 (3 LAB)
- CHE 298 Directed Research Project (6 PRJ) (optional extra)
- CHEM 262 Organic Chemistry for Engineering (3 LEC,1 TUT)
- CHEM 262L Organic Chemistry Laboratory for Engineering Students (3 LAB)
- MATH 217 Calculus 3 for Chemical Engineering (3 LEC,1 TUT)

Term 2B (Spring Stream 8D/Fall Stream 4D)

- CHE 211 Fluid Mechanics (3 LEC,1 TUT)
- CHE 225 Strategies for Process Improvement and Product Development (3 LEC,1 TUT)
- CHE 231 Physical Chemistry 2 (3 LEC,1 TUT)
- CHE 241 Materials Science and Engineering (3 LEC,1 TUT)
- CHE 291 Chemical Engineering Lab 2 (3 LAB)
- CHE 299 Directed Research Project (6 PRJ) (optional extra)
- MATH 218 Differential Equations for Engineers (3 LEC,1 TUT)

Term 3A (Winter Stream 8D/Spring Stream 4D)

- CHE 312 Mathematics of Heat and Mass Transfer (3 LEC,1 TUT)
- CHE 314 Chemical Reaction Engineering (3 LEC,1 TUT)
- CHE 322 Numerical Methods for Process Analysis and Design (3 LEC,1 TUT)
- CHE 330 Chemical Engineering Thermodynamics (3 LEC,1 TUT)
- CHE 390 Chemical Engineering Lab 3 (3 LAB)
- CHE 398 Directed Research Project (6 PRJ) (optional extra)

- MSCI 261 Engineering Economics: Financial Management for Engineers (3 LEC,1 TUT)

Term 3B (Fall Stream 4D/Winter Stream 8D)

- CHE 313 Applications of Heat and Mass Transfer (3 LEC,1 TUT)
- CHE 331 Electrochemical Engineering (3 LEC,1 TUT)
- CHE 341 Introduction to Process Control (3 LEC,1 TUT)
- CHE 361 Bioprocess Engineering (3 LEC,1 TUT)
- CHE 383 Chemical Engineering Design Workshop (2 LEC)
- CHE 399 Directed Research Project (6 PRJ) (optional extra)
- One TE Approved Technical Elective or CSE Complementary Studies Elective

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Term 4A (Fall)

- CHE 480 Process Analysis and Design (3 LEC,2 TUT)
- CHE 482 Group Design Project (1 SEM,9 PRJ)
- CHE 490 Chemical Engineering Lab 4 (4 LAB)
- CHE 450 Technical Work-term Report
- CHE 498 Directed Research Project (6 PRJ) (optional extra)
- Three TE Approved Technical Electives or CSE Complementary Studies Electives

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Term 4B (Winter)

- CHE 483 Group Design Project and Symposium (1 SEM,9 PRJ)
- CHE 491 Chemical Engineering Lab 5 (4 LAB)
- Four TE Approved Technical Electives or CSE Complementary Studies Electives

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Complementary Studies Electives

A total of five Complementary Studies Electives (CSEs), not including MSCI 261, must be taken. The first of these courses must satisfy the Undergraduate Communication Requirement (see below). If some Complementary Studies Electives are satisfied online or from other institutions on a Letter of Permission, when not in an academic term, each term's minimum course load must be maintained by substituting an approved "free" elective (technical or non-technical). For further details see Complementary Studies Requirements for Engineering Students.

Undergraduate Communication Requirement

Strong communication skills are essential to academic, professional, and personal success. To achieve the Undergraduate Communication Requirement, Chemical Engineering students must successfully complete a foundational course on communication. This course must be taken as the first Complementary Studies Elective course (CSE in the 1B term) and selected from the following list:

- ENGL 109 Introduction to Academic Writing
- ENGL 129R/EMLS 129R Written Academic English
- EMLS 101R Oral Communications for Academic Purposes
- EMLS 102R Clear Communication in English Writing
- SPCOM 100 Interpersonal Communication
- SPCOM 223 Public Speaking

Failure to achieve the Undergraduate Communication Requirement before the end of the 2A term will result in a term decision of May Not Proceed (MNP). Communication skills are further developed and evaluated through work-term reports, as well as through design-focused (CHE 180, CHE 181, CHE 383, CHE 482, CHE 483) and investigation-focused courses (CHE 390, CHE 490, CHE 491).

Work-term Reports and Reflection Milestone

Reflection is an integral part of work-integrated learning. To achieve the Work-term Reflection Milestone, Chemical Engineering students must complete a minimum of four reflective work-term reports, one associated with each work term. These are short, structured reports offering the opportunity to reflect on practical experience obtained in the context of their academic learning and the experience requirements for professional licensure.

Students are expected to continue to develop technical communication skills in the workplace. To facilitate this, students must take PD 11 Processes for Technical Report Writing as one of their PD electives, and also complete CHE 450 Technical Work-term Report.

Ethics and Equity Milestone

This degree milestone must be met by all graduating Chemical Engineering students by either completing one course from the following list (can be taken as a CSE):

- PHIL 215 Professional and Business Ethics
- PHIL 219J Practical Ethics
- PHIL 315/GENE 412 Ethics and The Engineering Profession

or by completing PD 22 Professionalism and Ethics in Engineering Practice.

Technical Electives

A total of four Technical Electives (TEs) courses must be taken. TEs for Chemical Engineering students are organized in three main thematic areas and may be selected from the following lists. Only one non-CHE course (i.e., from other departments) is permitted if CHE 499 is chosen. Otherwise, students may select up to two non-CHE TEs. Non-CHE courses will likely require permission of the instructor and/or other prerequisites. In brackets are recommended minimum levels that CHE students should be enrolled in before attempting a given course. Variations from this course selection list must be approved by the Department.

List 1 - Energy and Environmental Systems and Processes

- CHE 499 Elective Research Project (3B)
- CHE 500 Special Topics in Chemical Engineering (contact Department)
- CHE 514 Fundamentals of Petroleum Production (3B)
- CHE 516 Energy Systems Engineering (3B)
- CHE 520 Process Flowsheet Analysis (4B)
- CHE 565 Synthetic Biology Project Design (3B)
- CHE 571 Industrial Ecology (3B)
- CHE 572 Air Pollution Control (3B)
- CHE 574 Industrial Wastewater Pollution Control (3B)
- EARTH 458 Physical Hydrogeology (4A)
- EARTH 459 Chemical Hydrogeology (4B)
- ENVE 376 Biological Processes (3B)
- ENVE 573 Contaminant Transport (4B)
- ENVE 577 Engineering for Solid Waste Management (4B)
- ME 452 Energy Transfer in Buildings (4B)
- ME 459 Energy Conversion (3B)
- ME 571 Air Pollution (4B)

List 2 - Materials and Manufacturing Processes

- CHE 499 Elective Research Project (3B)
- CHE 500 Special Topics in Chemical Engineering (contact Department)
- CHE 520 Process Flowsheet Analysis (4B)
- CHE 541 Introduction to Polymer Science and Properties (3B)
- CHE 543 Polymer Production: Polymer Reaction Engineering (4B)
- CHE 561 Biomaterials and Biomedical Design (4B)
- CHE 562 Advanced Bioprocess Engineering (4B)
- CHE 564 Food Process Engineering (4B)
- CHE 565 Synthetic Biology Project Design (3B)
- CHE 571 Industrial Ecology (3B)
- ME 435 Industrial Metallurgy (4A)
- ME 531 Physical Metallurgy Applied to Manufacturing (4B)
- ME 533 Non-metallic and Composite Materials (4B)
- MSCI 432 Production and Service Operations Management (3B)
- MSCI 551 Quality Management and Control (3B)
- NE 352 Surfaces and Interfaces (4A)
- NE 481 Nanomedicine and Nanobiotechnology (4A)

List 3 - Chemical Process Modelling, Optimization, and Control

- CHE 499 Elective Research Project (3B)
- CHE 500 Special Topics in Chemical Engineering (contact Department)
- CHE 520 Process Flowsheet Analysis (4B)
- CHE 521 Process Optimization (3B)
- CHE 522 Advanced Process Dynamics and Control (4B)
- CHE 524 Process Control Laboratory (4B)
- CHE 565 Synthetic Biology Project Design (3B)
- EARTH 456 Numerical Methods in Hydrogeology (4A)
- ME 362 Fluid Mechanics 2 (3B)
- ME 559 Finite Element Methods (3B)
- ME 566 Computational Fluid Dynamics for Engineering Design (4A)
- MSCI 332 Deterministic Optimization Models and Methods (3B)
- MSCI 431 Stochastic Models and Methods (4B)
- MSCI 432 Production and Service Operations Management (3B)
- MSCI 551 Quality Management and Control (3B)
- NE 451 Simulation Methods (4A)
- SYDE 531 Design Optimization Under Probabilistic Uncertainty (4B)

Information for all undergraduate courses, including Chemical Engineering, can be found in the Course Descriptions section of this Calendar.

Specializations

The Faculty of Engineering recognizes three designated specializations within the BASc degree in Chemical Engineering: Energy and Environmental Systems and Processes Specialization, Materials and Manufacturing Processes Specialization, and Chemical Process Modelling, Optimization and Control Specialization. Students interested in pursuing one of these specializations must take four required technical elective courses from the corresponding list of approved technical electives (List 1, List 2, or List 3). A minimum average of 60% in the four specialization courses and a grade of at least 50% in each of the four courses is required. Students who satisfy the requirements for Options, Specializations and Electives for Engineering Students will have the appropriate designation shown on their diploma and transcript.

1. The Energy and Environmental Systems and Processes Specialization (List 1).
2. The Materials and Manufacturing Processes Specialization (List 2).
3. The Chemical Process Modelling, Optimization and Control Specialization (List 3).

Civil Engineering

The Civil Engineering Academic Curriculum

A total of three approved Complementary Studies Electives (CSE), in addition to ENGL 191/SPCOM 191, CIVE 392, and CIVE 491, and eight approved Technical Electives (TE) must be completed as detailed in the following sections.

Term 1A (Fall)

- CHE 102 Chemistry for Engineers
- CIVE 100 Civil Engineering Concepts
- CIVE 104 Mechanics 1
- CIVE 115 Linear Algebra
- ENGL 191/SPCOM 191 Communication in the Engineering Profession (List D-Other CSE)
- MATH 116 Calculus 1 for Engineering

Term 1B (Winter)

- CIVE 105 Mechanics 2
- CIVE 121 Computational Methods
- CIVE 123 Electrical Circuits and Instrumentation
- CIVE 153 Earth Engineering
- CIVE 199 Seminar
- MATH 118 Calculus 2 for Engineering

Term 2A (Fall)

- CIVE 204 Solid Mechanics 1
- CIVE 221 Advanced Calculus
- CIVE 224 Probability and Statistics

- CIVE 241 Transport Principles and Applications
- CIVE 265 Structure and Properties of Materials
- CIVE 298 Seminar

Term 2B (Spring)

- CIVE 205 Solid Mechanics 2
- CIVE 222 Differential Equations
- CIVE 230 Engineering and Sustainable Development
- CIVE 280 Fluid Mechanics
- CIVE 299 Seminar
- CIVE 392 Economics and Life Cycle Cost Analysis (List B-Engineering Economics CSE)

Term 3A (Winter)

- CIVE 303 Structural Analysis
- CIVE 332 Civil Systems and Project Management
- CIVE 341 Transportation Engineering Applications
- CIVE 353 Geotechnical Engineering 1
- CIVE 382 Hydrology and Open Channel Flow
- CIVE 398 Seminar
- CSE 1 Approved Complementary Studies Elective
- WKRPT 200 Work-term Report

Term 3B (Fall)

- CIVE 310 Introduction to Structural Design
- CIVE 375 Environmental Engineering Principles
- CIVE 399 Seminar
- TE 1 Approved Technical Elective
- TE 2 Approved Technical Elective
- CSE 2 or TE 3 Approved Complementary Studies Elective or Technical Elective
- WKRPT 300 Work-term Report

Note: Elective must be a Technical Elective (TE) if Complementary Studies Elective (CSE) is selected in a previous term, and vice versa.

Term 4A (Spring)

- CIVE 400 Civil Engineering Design Project 1
- CIVE 491 Engineering Law and Ethics (List D-Other CSE)
- CIVE 498 Seminar
- TE 3 or CSE 2 Approved Technical Elective or Complementary Studies Elective
- TE 4 Approved Technical Elective
- CSE 3 or TE 5 Approved Complementary Studies Elective or Technical Elective
- WKRPT 400 Work-term Report

Note: Elective must be a Technical Elective (TE) if Complementary Studies Elective (CSE) is selected in a previous term, and vice versa.

Term 4B (Winter)

- CIVE 401 Civil Engineering Design Project 2
- CIVE 499 Seminar
- CSE 3 or TE 5 Approved Complementary Studies Elective or Technical Elective
- TE 6 Approved Technical Elective
- TE 7 Approved Technical Elective
- TE 8 Approved Technical Elective

Note: Elective must be a Technical Elective (TE) if Complementary Studies Elective (CSE) is selected in a previous term, and vice versa.

Electives

Students are responsible for selecting their own combination of electives, in keeping with their ultimate career objectives after graduation. The combination must satisfy the requirements of the Department of Civil and Environmental Engineering (CEE), which meet engineering accreditation requirements such that students are eligible to count their undergraduate education towards a professional engineering license.

This includes having to meet minimum requirements in mathematics, natural sciences, engineering sciences, engineering design, and complementary studies.

Exceptions to courses on the Faculty CSE lists and the Civil Engineering TE and Specialization Lists require the approval of the CEE associate chair undergraduate studies. Some courses of interest may require prerequisite knowledge that is not part of the core curriculum in Civil Engineering. Students may require extra courses or may need to seek enrolment approval from the course instructor if the prerequisites have not been satisfied.

Complementary Studies Electives

All engineering students are required to take complementary studies courses, as described in Complementary Studies Requirements for Engineering Students. Three complementary studies electives (CSEs) in approved non-technical subjects, must be taken. The CSEs are in addition to those courses which are part of the core curriculum and contain complementary studies material, such as ENGL 191/SPCOM 191 (List D), CIVE 392 (List B), and CIVE 491 (List D). The three CSE courses are to be chosen according to the following constraints:

- One course from List A - Impact Courses
- Two courses from List C - Humanities and Social Sciences Courses

Technical Electives

Students are required to complete eight technical elective (TE) courses within the following requirements:

1. At least three TEs must be from TE List A (Engineering Design Intensive Technical Electives)
2. Up to four TEs may be from TE List B (Technical Electives)
3. One TE must be from TE List C (Natural Science Technical Electives)

The Technical Elective Lists for Civil Engineering are provided below. Note that the offering of these courses is contingent upon sufficient demand and/or available teaching resources. There may be courses added and changes made to the content, term of offering, or meet times from what is listed below. Special Topics courses (CIVE 495 and CIVE 497) are offered as resources and faculty availability permit. Further information is available from the CEE Undergraduate Office or CEE website.

Legend for TE List A, B, and C

Term courses are offered: F=fall term, W=winter term, S=spring term

TE List A - Engineering Design Intensive Technical Electives

Choose at least three

- CIVE 343 Traffic Simulation Modelling and Applications (F)
- CIVE 354 Geotechnical Engineering 2 (F)
- CIVE 413 Structural Steel Design (S)
- CIVE 414 Structural Concrete Design (S)
- CIVE 415 Structural System Design (W)
- CIVE 460 Engineering Biomechanics (W)
- CIVE 495 Design Intensive Special Topics in Civil Engineering (as offered)
- CIVE 512 Rehabilitation of Structures (W)
- CIVE 542 Pavement Structural Design (W)
- CIVE 554 Geotechnical Engineering 3 (W)
- CIVE 583 Design of Urban Water Systems (W)
- CIVE 596 Construction Engineering (S)
- EARTH 438 Engineering Geology (W)
- ENVE 577 Engineering for Solid Waste Management (W)
- SYDE 533 Conflict Resolution (F)

TE List B - Technical Electives

Choose a maximum of four

- CIVE 306 Mechanics of Solids 3 (F)
- CIVE 422 Finite Element Analysis (W)
- CIVE 440 Transit Planning and Operations (W)
- CIVE 484 Physical Infrastructure Planning (S)
- CIVE 497 Special Topics in Civil Engineering (as offered)
- CIVE 505 Structural Dynamics (S)
- CIVE 507 Building Science and Technology (W)
- EARTH 444 Applied Wetland Science (F)
- EARTH 458 Physical Hydrogeology (F,S)
- ENVE 277 Air Quality Engineering (F)
- ENVE 279 Energy and the Environment (F)
- ENVE 376 Biological Processes (W)
- ENVE 383 Advanced Hydrology and Hydraulics (W)
- ENVE 573 Contaminant Transport (W)
- GEOG 209 Hydrogeology (W,S)
- GEOG 305 Fluvial Geomorphology (F)
- GEOG 371 Advanced Remote Sensing Techniques (F)
- GEOG 381 Advanced Geographic Information Systems (W,S)
- ME 559 Finite Element Methods (F,S)
- PLAN 416 Modelling the City (W)
- PLAN 477 Freight Planning and Policy (W)

TE List C - Natural Science Technical Electives

Choose one

- BIOL 130 Introductory Cell Biology (F,W)
- BIOL 150 Organismal and Evolutionary Ecology (F)
- BIOL 240 Fundamentals of Microbiology (F)
- BIOL 273 Principles of Human Physiology 1 (F,W, and online S)
- CHE 161 Engineering Biology (W,S)
- CHEM 209 Introductory Spectroscopy and Structure (F)
- CHEM 262 Organic Chemistry for Engineering (F,W)
- EARTH 221 Introductory Geochemistry (W,S)
- EARTH 270 Disasters and Natural Hazards (W)
- EARTH 281 Geological Impacts on Human Health (W)
- ENVS 200 Field Ecology (F,W,S)
- KIN 100 Regional Human Anatomy and KIN 100L Regional Human Anatomy Laboratory (W)
- SCI 207 Physics, the Universe, and Everything (W)
- SCI 238 Introductory Astronomy (F,W,S)

Specializations

The Faculty of Engineering recognizes four specializations with the Civil Engineering BASc degree. Students who satisfy the specialization requirements (courses and grades) will have the specialization designation shown on their transcript and diploma. Specializations are intended to recognize success in a concentration of electives within the Civil Engineering degree specification. In other words, specializations focus the selection of electives required for the base degree and do not require extra courses.

Each specialization requires students to select technical electives with a common theme. Students are responsible for meeting the TE requirements of the Civil Engineering plan when pursuing a specialization. Each specialization requires the successful completion of a minimum number of TEs specified by the specialization with a minimum average of 60%. Students must declare a specialization for it to be recognized as part of their degree and appear on the transcript and diploma.

Exceptions to the listed courses require the approval of the CEE associate chair, undergraduate studies.

Geotechnical Specialization

The Geotechnical Specialization course requirements are:

- CIVE 354 Geotechnical Engineering 2 (F, TE List A)
- CIVE 554 Geotechnical Engineering 3 (W, TE List A)
- At least two additional TEs from the list below.
    - From TE List A:

        - CIVE 414 Structural Concrete Design (S)
        - CIVE 542 Pavement Structural Design (W)
    - From TE List B:
        - CIVE 422 Finite Element Analysis (W) or ME 559 Finite Element Methods (F,S)
        - EARTH 438 Engineering Geology (W)

Structural Specialization

The Structural Specialization course requirements are:

- At least five TEs from the list below, of which one must be CIVE 413 or CIVE 414.
    - From TE List A:
        - CIVE 413 Structural Steel Design (S)
        - CIVE 414 Structural Concrete Design (S)
        - CIVE 415 Structural System Design (W)
        - CIVE 460 Engineering Biomechanics (W)
        - CIVE 512 Rehabilitation of Structures (W)
        - CIVE 596 Construction Engineering (S)
    - From TE List B:
        - CIVE 306 Mechanics of Solids 3 (F)
        - CIVE 422 Finite Element Analysis (W)
        - CIVE 505 Structural Dynamics (S)
        - CIVE 507 Building Science and Technology (W)

Transportation Specialization

The Transportation Specialization course requirements are:

- At least four TEs from the list below, of which at least three must be CIVE courses.
    - From TE List A:
        - CIVE 343 Traffic Simulation Modelling and Applications (F)
        - CIVE 542 Pavement Structural Design (W)
    - From TE List B:
        - CIVE 440 Transit Planning and Operations (W)
        - CIVE 484 Physical Infrastructure Planning (S)
        - GEOG 381 Advanced Geographic Information Systems (W,S)
        - PLAN 416 Modelling the City (W)
        - PLAN 477 Freight Planning and Policy (W)

Water Resources Specialization

The Water Resources Specialization course requirements are:

- ENVE 383 Advanced Hydrology and Hydraulics (W, TE List B)
- At least three TEs from the list below.
    - From TE List A:
        - CIVE 583 Design of Urban Water Systems (W)
        - SYDE 533 Conflict Resolution (F)
    - From TE List B:
        - EARTH 444 Applied Wetland Science (F)
        - EARTH 458 Physical Hydrogeology (F,S)
        - ENVE 376 Biological Processes (W)
        - ENVE 573 Contaminant Transport (W)
        - GEOG 209 Hydroclimatology (W,S)
        - GEOG 305 Fluvial Geomorphology (F)
        - GEOG 371 Advanced Remote Sensing Techniques (F)
        - GEOG 381 Advanced Geographic Information Systems (W,S)

Computer Engineering

The Computer Engineering Academic Curriculum

The curriculum involves a prescribed course load in each term along with some academic milestones, which must be completed at or before specified times. Laboratory sessions are compulsory where they form part of a course. Approval from the Electrical and Computer Engineering (ECE) Undergraduate Office is required for all changes from the specified plan. Permission to carry more than the normal load in any term is at the

discretion of the ECE Undergraduate Office and is dependent on both the student's previous term average and their cumulative average.

There are six co-operative work terms and the normal rules of Co-operative Education apply, as further described in the Faculty of Engineering Work Terms page of this Calendar. With permission and co-ordination through the ECE Undergraduate Office, it is possible to create eight-month co-operative work terms by rearranging the term sequence. At least five successful work terms are required to meet the degree requirements.

The promotion criteria used to determine progression through the plan are described in the Engineering Examinations and Promotions section of this Calendar. These include term-average requirements, course-grade requirements, and milestone requirements.

Term 1A (Fall)

- ECE 105 Classical Mechanics
- ECE 150 Fundamentals of Programming
- ECE 190 Engineering Profession and Practice
- ECE 198 Project Studio
- ENGL 192/SPCOM 192 Communication in the Engineering Profession
- MATH 115 Linear Algebra for Engineering
- MATH 117 Calculus 1 for Engineering
- Workplace Hazardous Materials Milestone (see Note 1)

Term 1B (Winter Stream 8/Spring Stream 4F)

- ECE 101A (stream 4F) Work-term Reflections (see Note 1)
- ECE 102 Information Session
- ECE 106 Electricity and Magnetism
- ECE 108 Discrete Mathematics and Logic 1
- ECE 124 Digital Circuits and Systems
- ECE 140 Linear Circuits
- ECE 192 Engineering Economics and Impact on Society
- MATH 119 Calculus 2 for Engineering

Term 2A (Fall Stream 8/Winter Stream 4F)

- ECE 101B (stream 4F) or ECE 101A (stream 8) Work-term Reflections (see Note 1)
- ECE 109 Materials Chemistry for Engineers
- ECE 201 Information Session
- ECE 204 Numerical Methods
- ECE 205 Advanced Calculus 1 for Electrical and Computer Engineers
- ECE 222 Digital Computers
- ECE 240 Electronic Circuits 1
- ECE 250 Algorithms and Data Structures

Term 2B (Spring Stream 8/Fall Stream 4F)

- ECE 101C (stream 4F) or ECE 101B (stream 8) Work-term Reflections (see Note 1)
- ECE 202 Information Session
- ECE 203 Probability Theory and Statistics 1
- ECE 207 Signals and Systems
- ECE 208 Discrete Mathematics and Logic 2
- ECE 224 Embedded Microprocessor Systems
- ECE 252 Systems Programming and Concurrency
- ECE 298 Instrumentation and Prototyping Laboratory

Term 3A (Winter Stream 8/Spring Stream 4F)

- ECE 101D (stream 4) or ECE 101C (stream 8) Work-term Reflections (see Note 1)
- ECE 301 Information Session
- ECE 318 Communication Systems
- ECE 327 Digital Hardware Systems
- ECE 350 Real-Time Operating Systems
- ECE 380 Analog Control Systems
- One CSE, NSE, or TE (see Note 2)

Term 3B (Fall)

- ECE 101D (stream 8) Work-term Reflections (see Note 1)
- ECE 302 Information Session
- ECE 307 Probability Theory and Statistics 2
- One CSE, NSE, or TE (see Note 2)
- Choose two of the following four courses (see Note 4)
  - ECE 320 Computer Architecture
  - ECE 351 Compilers
  - ECE 356 Database Systems
  - ECE 358 Computer Networks
- Choose one additional course from ECE 313, ECE 320, ECE 331, ECE 351, ECE 356, ECE 358, ECE 360, ECE 373 that has not already been selected above provided prerequisites are met and subject to scheduling constraints.

Term 4A (Spring)

- ECE 101E Work-term Reflections (see Note 1)
- ECE 401 Information Session
- ECE 498A Engineering Design Project or GENE 403 Interdisciplinary Design Project 1 (see Notes 5 and 6)
- Four elective courses, CSE, NSE, or TE, as necessary (see Note 2)

Term 4B (Winter)

- ECE 402 Information Session (1 SEM)
- ECE 498B Engineering Design Project or GENE 404 Interdisciplinary Design Project 2 (see Notes 5 and 6)
- Four elective courses, CSE, NSE, or TE, as necessary (see Note 2)

Notes

1. Milestones have deadlines for successful completion and are shown in the terms (such as WHMIS in the 1A term) where they are normally completed. Work-term Reflections courses (ECE 101A, ECE 101B, ECE 101C, ECE 101D, and ECE 101E) are credit/no credit (CR/NCR). Further information is provided in the Work-term Reflections section.
2. There are a total of 13 electives: eight technical electives (TEs), including three in the 3B term which must be chosen from a list, three complementary studies electives (CSEs), and two natural science electives (NSEs). Constraints on the selection of TEs, CSEs, and NSEs are explained below. As per the Engineering Examinations and Promotions rules, these electives form part of a regular course load.
3. Students may take any Professional Development (PD) course approved by the Faculty of Engineering. Students must complete PD 19 and PD 20, as well as three PD elective courses to satisfy degree requirements. Among the three PD elective courses, students can take PD 22 to satisfy the Ethics Requirement as explained below.
4. During the 3B term, students must select three technical courses from a list. These courses cannot be dropped for a reduced-load term.
5. In their 4A and 4B terms, students must enrol in the ECE 498A and ECE 498B sequence or the GENE 403 and GENE 404 sequence. ECE 498A and GENE 404, and ECE 498B and GENE 403 combinations are not allowed.
6. Students in the Biomechanics Option or the Mechatronics Option must choose a compatible topic for their design project sequence in ECE 498A and ECE 498B. See the option description or option co-ordinator for details.
7. Special topics courses (ECE 493) are offered as resources and faculty interests permit. Students should consult the ECE Undergraduate Office or ECE website for upcoming topics. Some offerings may have laboratory meets.

Work-term Reflections

For each of the Work-term Reflections courses ECE 101A, ECE 101B, ECE 101C, ECE 101D, and ECE 101E, students write a short two-page report (from an online template available on the ECE website) reflecting on their work experience during the previous co-op term. Students submit it for grading in the academic term that follows the work term. If a student did not secure a co-op position, they are to reflect on what

skills they used to improve their chances of a co-op position in future work terms. These courses are graded as credit/no credit (CR/NCR).

Elective Courses

Complementary Studies Electives

Students must complete three complementary studies electives (CSEs) to satisfy the Complementary Studies Requirements for Engineering Students. These are in addition to those courses that are part of the core curriculum and contain complementary studies material, such as ECE 190, ECE 192, and the Professional Development (PD) sequence. The three CSE courses are to be chosen according to the following constraints:

- Two from List C (Humanities and Social Sciences Courses)
- One from any of List A (Impact Courses), List C (Humanities and Social Sciences Courses), or List D (Other Permissible Complementary Studies Courses)

Students may take up to one technique course (i.e., learning a skill or language) as part of List D. Technique courses need ECE Undergraduate Office approval to be considered as complementary studies electives.

Students may take GENE 412/PHIL 315 as a List C CSE in which case the course will also satisfy the Ethics Requirement.

Ethics Requirement

To meet the Ethics Requirement, students must pass one of PD 22 or GENE 412/PHIL 315.

Natural Science Electives

Students are required to complete two natural science electives (NSEs), and are responsible for ensuring they meet the minimum academic units. The two NSE courses must be primarily concerned with natural science and are in addition to the science components of the core curriculum, such as ECE 105, ECE 106, and ECE 109.

- BIOL 110 Introductory Zoology
- BIOL 130 Introductory Cell Biology and BIOL 130L Cell Biology Laboratory
- BIOL 150 Organismal and Evolutionary Ecology
- BIOL 165 Diversity of Life
- BIOL 211 Introductory Vertebrate Zoology
- BIOL 240 Fundamentals of Microbiology and BIOL 240L Microbiology Laboratory
- BIOL 241 Introduction to Applied Microbiology
- BIOL 273 Principles of Human Physiology 1
- BIOL 373 Principles of Human Physiology 2 and BIOL 373L Human Physiology Laboratory
- CHE 161 Engineering Biology
- CHEM 123 General Chemistry 2 and CHEM 123L General Chemistry Laboratory 2
- CHEM 209 Introductory Spectroscopy and Structure
- CHEM 237 Introductory Biochemistry, and CHEM 237L Introductory Biochemistry Laboratory
- CHEM 254 Introductory Chemical Thermodynamics
- CHEM 262 Organic Chemistry for Engineering and CHEM 262L Organic Chemistry Laboratory for Engineering Students
- CHEM 266 Basic Organic Chemistry 1
- CHEM 356 Introductory Quantum Mechanics
- CHEM 404 Physiochemical Aspects of Natural Waters
- EARTH 121 Introductory Earth Sciences
- EARTH 122 Introductory Environmental Sciences
- EARTH 123 Introductory Hydrology
- EARTH 221 Introductory Geochemistry
- EARTH 270 Disasters and Natural Hazards
- EARTH 281 Geological Impacts on Human Health
- ECE 231 Semiconductor Physics and Devices
- ECE 403 Thermal Physics
- ECE 404 Geometrical and Physical Optics
- ECE 405 Introduction to Quantum Mechanics
- ENVE 275 Environmental Chemistry
- ENVS 200 Field Ecology
- NE 222 Organic Chemistry for Nanotechnology Engineers
- PHYS 234 Quantum Physics 1

- PHYS 263 Classical Mechanics and Special Relativity
- PHYS 275 Planets
- PHYS 280 Introduction to Biophysics
- PHYS 334 Quantum Physics 2
- PHYS 335 Condensed Matter Physics
- PHYS 375 Stars
- PHYS 380 Molecular and Cellular Biophysics
- SCI 238 Introductory Astronomy

Technical Electives

Students are required to complete a total of eight technical electives (TEs), subject to the following conditions:

1. All of the technical courses from the 3B term (i.e., ECE 313, ECE 320, ECE 331, ECE 351, ECE 356, ECE 358, ECE 360, and ECE 373) count as TEs. At least three of these courses must be taken in the 3B term, as specified in the curriculum above.
2. At least three TEs must be courses chosen from ECE 406 through ECE 495 or ECE 499, normally taken during the 4A and 4B terms. A list of current 4A and 4B TEs is provided below.
3. At least one TE, to a maximum of two, must be from another engineering (other than Electrical or Computer Engineering) plan; such courses must have sufficiently advanced engineering science or engineering design content to be allowed, and must be approved by the ECE Undergraduate Office. Some courses of interest may require prerequisite knowledge that is not part of the core curriculum in Computer Engineering. Students may require extra courses or may need to seek enrolment approval from the course instructor if the prerequisite knowledge was acquired by other means.
4. The following courses are offered in the core curriculum in Electrical Engineering but are considered TE courses for Computer Engineering: ECE 260, ECE 340, and ECE 375. Some of these courses have prerequisites that must be met in order to enrol.
5. In all terms, elective availability is subject to scheduling constraints.

The following TE courses are normally offered for the spring (4A) term. The list is subject to change from year to year.

- ECE 414 Wireless Communications
- ECE 433 Fabrication Technologies for Micro and Nano Devices
- ECE 445 Integrated Digital Electronics
- ECE 452 Software Design and Architectures
- ECE 454 Distributed Computing
- ECE 455 Embedded Software
- ECE 457A Co-operative and Adaptive Algorithms
- ECE 457C Reinforcement Learning
- ECE 458 Computer Security
- ECE 462 Electrical Distribution Systems
- ECE 463 Design & Applications of Power Electronic Converters
- ECE 475 Radio-Wave Systems
- ECE 481 Digital Control Systems
- ECE 486 Robot Dynamics and Control
- ECE 493 Special Topics in Electrical and Computer Engineering (see Note 7)

The following TE courses are normally offered for the winter (4B) term. The list is subject to change from year to year.

- ECE 406 Algorithm Design and Analysis
- ECE 409 Cryptography and System Security
- ECE 416 Advanced Topics in Networking
- ECE 417 Image Processing
- ECE 423 Embedded Computer Systems
- ECE 432 Radio Frequency Integrated Devices and Circuits
- ECE 444 Integrated Analog Electronics
- ECE 451 Software Requirements Specification and Analysis
- ECE 453 Software Testing, Quality Assurance and Maintenance
- ECE 457B Fundamentals of Computational Intelligence
- ECE 459 Programming for Performance
- ECE 464 High Voltage Engineering and Power System Protection
- ECE 467 Power Systems Analysis, Operations and Markets

- ECE 474 Radio and Wireless Systems
- ECE 477 Photonic Devices and Systems
- ECE 488 Multivariable Control Systems
- ECE 493 Special Topics in Electrical and Computer Engineering (see Note 7)
- ECE 495 Autonomous Vehicle

The following project elective is offered every term. Students may take it, at most, once as a TE course.

- ECE 499 Engineering Project

Workplace Hazardous Materials Information System (WHMIS)

All students must take WHMIS training. Details are described in the WHMIS Requirements section of this Calendar. Students must meet this milestone in order to remain enrolled in 1A or to enrol in any academic term beyond 1A.

Communications and Signal Processing Specialization

Students interested in pursuing this Specialization must achieve a minimum average of 60% in the specialization courses, and a minimum grade of 50% in each of the courses. Students who satisfy the requirements for Faculty Options, Specializations and Electives for Engineering Students will have the appropriate designation shown on their diploma and transcript.

Required courses:

- ECE 313 Digital Signal Processing
- ECE 318 Communication Systems

Any three courses from the following list:

- ECE 358 Computer Networks
- ECE 414 Wireless Communications
- ECE 416 Advanced Topics in Networking
- ECE 417 Image Processing
- ECE 474 Radio and Wireless Systems

Electrical Engineering

The Electrical Engineering Academic Curriculum

The curriculum involves a prescribed course load in each term along with some academic milestones, which must be completed at or before specified times. Laboratory sessions are compulsory where they form part of a course. Approval from the Electrical and Computer Engineering (ECE) Undergraduate Office is required for all changes from the specified plan. Permission to carry more than the normal load in any term is at the discretion of the ECE Undergraduate Office and is dependent on both the student's previous term average and their cumulative average.

There are six co-operative work terms and the normal rules of Co-operative Education apply, as further described in the Faculty of Engineering Work Terms page of this Calendar. With permission and co-ordination through the ECE Undergraduate Office, it is possible to create eight-month co-operative work terms by rearranging the term sequence. At least five successful work terms are required to meet the degree requirements.

The promotion criteria used to determine progression through the plan are described in the Engineering Examinations and Promotions section of this Calendar. These include term-average requirements, course-grade requirements, and milestone requirements.

The term-by-term academic component of the curriculum is as follows:

Term 1A (Fall)

- ECE 105 Classical Mechanics
- ECE 150 Fundamentals of Programming
- ECE 190 Engineering Profession and Practice
- ECE 198 Project Studio
- ENGL 192/SPCOM 192 Communication in the Engineering Profession
- MATH 115 Linear Algebra for Engineering
- MATH 117 Calculus 1 for Engineering
- Workplace Hazardous Materials Milestone (see Note 1)

Term 1B (Winter Stream 8/Spring Stream 4F)

- ECE 101A (stream 4F) Work-term Reflections (see Note 1)
- ECE 102 Information Session

- ECE 106 Electricity and Magnetism
- ECE 108 Discrete Mathematics and Logic 1
- ECE 124 Digital Circuits and Systems
- ECE 140 Linear Circuits
- ECE 192 Engineering Economics and Impact on Society
- MATH 119 Calculus 2 for Engineering

Term 2A (Fall Stream 8/Winter Stream 4F)

- ECE 101B (stream 4F) or ECE 101A (stream 8) Work-term Reflections (see Note 1)
- ECE 109 Materials Chemistry for Engineers
- ECE 201 Information Session
- ECE 204 Numerical Methods
- ECE 205 Advanced Calculus 1 for Electrical and Computer Engineers
- ECE 222 Digital Computers
- ECE 240 Electronic Circuits 1
- ECE 250 Algorithms and Data Structures

Term 2B (Spring Stream 8/Fall Stream 4F)

- ECE 101C (stream 4F) or ECE 101B (stream 8) Work-term Reflections (see Note 1)
- ECE 202 Information Session
- ECE 203 Probability Theory and Statistics 1
- ECE 206 Advanced Calculus 2 for Electrical Engineers
- ECE 207 Signals and Systems
- ECE 231 Semiconductor Physics and Devices
- ECE 260 Electromechanical Energy Conversion
- ECE 298 Instrumentation and Prototyping Laboratory

Term 3A (Winter Stream 8/Spring Stream 4F)

- ECE 101D (stream 4F) or ECE 101C (stream 8) Work-term Reflections (see Note 1)
- ECE 301 Information Session
- ECE 318 Communication Systems
- ECE 340 Electronic Circuits 2
- ECE 375 Electromagnetic Fields and Waves
- ECE 380 Analog Control Systems
- One CSE, NSE, or TE (see Note 2)

Term 3B (Fall)

- ECE 101D (stream 8) Work-term Reflections (see Note 1)
- ECE 302 Information Session
- ECE 307 Probability Theory and Statistics 2
- One CSE, NSE, or TE (see Note 2)
- Choose two of the following four courses (see Note 4)
    - ECE 313 Digital Signal Processing
    - ECE 331 Electronic Devices
    - ECE 360 Power Systems and Smart Grids
    - ECE 373 Radio Frequency and Microwave Circuits
- Choose one additional course from ECE 313, ECE 320, ECE 331, ECE 351, ECE 356, ECE 358, ECE 360, ECE 373 that has not already been selected above provided prerequisites are met and subject to scheduling constraints.

Term 4A (Spring)

- ECE 101E Work-term Reflections (see Note 1)
- ECE 401 Information Session
- ECE 498A Engineering Design Project or GENE 403 Interdisciplinary Design Project 1 (see Notes 5 and 6)
- Four elective courses, CSE, NSE, or TE, as necessary (see Note 2)

Term 4B (Winter)

- ECE 402 Information Session

- ECE 498B Engineering Design Project or GENE 404 Interdisciplinary Design Project 2 (see Notes 5 and 6)
- Four elective courses, CSE, NSE, or TE, as necessary (see Note 2)

Notes

1. Milestones have deadlines for successful completion and are shown in the terms (such as WHMIS in the 1A term) where they are normally completed. Work-term Reflections courses (ECE 101A, ECE 101B, ECE 101C, ECE 101D, and ECE 101E) are credit/no credit (CR/NCR). Further information is provided in the Work-term Reflections section.
2. There are a total of 13 electives: eight technical electives (TEs), including three in the 3B term which must be chosen from a list, three complementary studies electives (CSEs), and two natural science electives (NSEs). Constraints on the selection of TEs, CSEs, and NSEs are explained below. As per the Engineering Examinations and Promotions rules, these electives form part of a regular course load.
3. Students may take any Professional Development (PD) course approved by the Faculty of Engineering. Students must complete PD 19 and PD 20, as well as three PD elective courses to satisfy degree requirements. Among the three PD elective courses, students can take PD 22 to satisfy the Ethics Requirement as explained below.
4. During the 3B term, students must select three technical courses from a list. These courses cannot be dropped for a reduced-load term.
5. In their 4A and 4B terms, students must enrol in the ECE 498A and ECE 498B sequence or the GENE 403 and GENE 404 sequence. ECE 498A and GENE 404, and ECE 498B and GENE 403 combinations are not allowed.
6. Students in the Biomechanics Option or the Mechatronics Option must choose a compatible topic for their design project sequence in ECE 498A, ECE 498B. See the option description or option co-ordinator for details.
7. Special topics courses (ECE 493) are offered as resources and faculty interests permit. Students should consult the ECE Undergraduate Office or ECE website for upcoming topics. Some offerings may have laboratory meets.

Work-term Reflections

For each of the Work-term Reflections courses ECE 101A, ECE 101B, ECE 101C, ECE 101D, and ECE 101E, students write a short two-page report (from an online template available on the ECE website) reflecting on their work experience during the previous co-op term. Students submit it for grading in the academic term that follows the work term. If a student did not secure a co-op position, they are to reflect on what skills they used to improve their chances of a co-op position in future work terms. These courses are graded as credit/no credit (CR/NCR).

Elective Courses

Complementary Studies Electives

Students must complete three complementary studies electives (CSEs) to satisfy the Complementary Studies Requirements for Engineering Students. These are in addition to those courses that are part of the core curriculum and contain complementary studies material, such as ECE 190, ECE 192, and the Professional Development (PD) sequence. The three CSE courses are to be chosen according to the following constraint:

- Two from List C (Humanities and Social Sciences Courses)
- One from any of List A (Impact Courses), List C (Humanities and Social Sciences Courses), or List D (Other Permissible Complementary Studies Courses)

Students may take up to one technique course (i.e., learning a skill or language) as part of List D. Technique courses need ECE Undergraduate Office approval to be considered as complementary studies electives.

Students may take GENE 412/PHIL 315 as a List C CSE in which case the course will also satisfy the Ethics Requirement.

Ethics Requirement

To meet the Ethics Requirement, students must pass one of PD 22 or GENE 412/PHIL 315.

Natural Science Electives

Students are required to complete two natural science electives (NSEs), and are responsible for ensuring they meet the minimum academic units. The two NSE courses must be primarily concerned with natural

science and are in addition to the science components of the core curriculum, such as ECE 105, ECE 106, ECE 109, and ECE 231.

- BIOL 110 Introductory Zoology
- BIOL 130 Introductory Cell Biology and BIOL 130L Cell Biology Laboratory
- BIOL 150 Organismal and Evolutionary Ecology
- BIOL 165 Diversity of Life
- BIOL 211 Introductory Vertebrate Zoology
- BIOL 240 Fundamentals of Microbiology and BIOL 240L Microbiology Laboratory
- BIOL 241 Introduction to Applied Microbiology
- BIOL 273 Principles of Human Physiology 1
- BIOL 373 Principles of Human Physiology 2 and BIOL 373L Human Physiology Laboratory
- CHE 161 Engineering Biology
- CHEM 123 General Chemistry 2 and CHEM 123L General Chemistry Laboratory 2
- CHEM 209 Introductory Spectroscopy and Structure
- CHEM 237 Introductory Biochemistry and CHEM 237L Introductory Biochemistry Laboratory
- CHEM 254 Introductory Chemical Thermodynamics
- CHEM 262 Organic Chemistry for Engineering and CHEM 262L Organic Chemistry Laboratory for Engineering Students
- CHEM 266 Basic Organic Chemistry 1
- CHEM 356 Introductory Quantum Mechanics
- CHEM 404 Physiochemical Aspects of Natural Waters
- EARTH 121 Introductory Earth Sciences
- EARTH 122 Introductory Environmental Sciences
- EARTH 123 Introductory Hydrology
- EARTH 221 Introductory Geochemistry
- EARTH 270 Disasters and Natural Hazards
- EARTH 281 Geological Impacts on Human Health
- ECE 403 Thermal Physics
- ECE 404 Geometrical and Physical Optics
- ECE 405 Introduction to Quantum Mechanics
- ENVE 275 Environmental Chemistry
- ENVS 200 Field Ecology
- NE 222 Organic Chemistry for Nanotechnology Engineers
- PHYS 234 Quantum Physics 1
- PHYS 263 Classical Mechanics and Special Relativity
- PHYS 275 Planets
- PHYS 280 Introduction to Biophysics
- PHYS 334 Quantum Physics 2
- PHYS 335 Condensed Matter Physics
- PHYS 375 Stars
- PHYS 380 Molecular and Cellular Biophysics
- SCI 238 Introductory Astronomy

Technical Electives

Students are required to complete a total of eight technical electives (TEs), subject to the following conditions:

1. All of the technical courses from the 3B term (i.e., ECE 313, ECE 320, ECE 331, ECE 351, ECE 356, ECE 358, ECE 360, and ECE 373) count as TEs. At least three of these courses must be taken in the 3B term, as specified in the curriculum table above.
2. At least three TEs must be courses chosen from ECE 406 through ECE 495 or ECE 499, normally taken during the 4A and 4B terms. A list of current 4A and 4B TEs is provided below.
3. At least one TE, to a maximum of two, must be from another engineering (other than Electrical or Computer Engineering) plan; such courses must have sufficiently advanced engineering science or engineering design content to be allowed, and must be approved by the ECE Undergraduate Office. Some courses of interest may require prerequisite knowledge that is not part of the core curriculum in Electrical Engineering. Students may require extra courses or may need to seek enrolment approval from the course instructor if the prerequisite knowledge was acquired by other means.
4. The following courses are offered in the core curriculum in Computer Engineering but are considered TE courses for Electrical Engineering: ECE 224, ECE 252, ECE 327, and ECE 350. Some of these courses have prerequisites that must be met in order to enrol.

5. In all terms, elective availability is subject to scheduling constraints.

The following TE courses are normally offered for the spring (4A) term. The list is subject to change from year to year.

- ECE 414 Wireless Communications
- ECE 433 Fabrication Technologies for Micro and Nano Devices
- ECE 445 Integrated Digital Electronics
- ECE 452 Software Design and Architectures
- ECE 454 Distributed Computing
- ECE 455 Embedded Software
- ECE 457A Co-operative and Adaptive Algorithms
- ECE 457C Reinforcement Learning
- ECE 458 Computer Security
- ECE 462 Electrical Distribution Systems
- ECE 463 Design & Applications of Power Electronic Converters
- ECE 475 Radio-Wave Systems
- ECE 481 Digital Control Systems
- ECE 486 Robot Dynamics and Control
- ECE 493 Special Topics in Electrical and Computer Engineering (see Note 7)

The following TE courses are normally offered for the winter (4B) term. The list is subject to change from year to year.

- ECE 406 Algorithm Design and Analysis
- ECE 409 Cryptography and System Security
- ECE 416 Advanced Topics in Networking
- ECE 417 Image Processing
- ECE 423 Embedded Computer Systems
- ECE 432 Radio Frequency Integrated Devices and Circuits
- ECE 444 Integrated Analog Electronics
- ECE 451 Software Requirements Specification and Analysis
- ECE 453 Software Testing, Quality Assurance and Maintenance
- ECE 457B Fundamentals of Computational Intelligence
- ECE 459 Programming for Performance
- ECE 464 High Voltage Engineering and Power System Protection
- ECE 467 Power Systems Analysis, Operations and Markets
- ECE 474 Radio and Wireless Systems
- ECE 477 Photonic Devices and Systems
- ECE 488 Multivariable Control Systems
- ECE 493 Special Topics in Electrical and Computer Engineering (see Note 7)
- ECE 495 Autonomous Vehicle

The following project elective is offered every term. Students may take it, at most, once as a TE course.

- ECE 499 Engineering Project

Workplace Hazardous Materials Information System (WHMIS)

All students must take WHMIS training. Details are described in the WHMIS Requirements section of this Calendar. Students must meet this milestone in order to remain enrolled in 1A or to enrol in any academic term beyond 1A.

Communications and Signal Processing Specialization

Students interested in pursuing this Specialization must achieve a minimum average of 60% in the specialization courses, and a minimum grade of 50% in each of the courses. Students who satisfy the requirements for Faculty Options, Specializations and Electives for Engineering Students will have the appropriate designation shown on their diploma and transcript.

Required courses:

- ECE 313 Digital Signal Processing
- ECE 318 Communication Systems

Any three courses from the following list:

- ECE 358 Computer Networks
- ECE 414 Wireless Communications
- ECE 416 Advanced Topics in Networking

- ECE 417 Image Processing
- ECE 474 Radio and Wireless Systems

Environmental Engineering

The Environmental Engineering Academic Curriculum

A total of two approved Complementary Studies Electives (CSE) in addition to ENGL 191/SPCOM 191, ERS 215, ENVE 391, and ENVE 392, and seven approved Technical Electives (TE) must be completed as detailed in the following sections.

Term 1A (Fall)

- CHE 102 Chemistry for Engineers
- CIVE 104 Mechanics 1
- ENVE 100 Environmental and Geological Engineering Concepts
- ENVE 115 Linear Algebra
- ENGL 191/SPCOM 191 Communication in the Engineering Profession (List D-Other CSE)
- MATH 116 Calculus 1 for Engineering

Term 1B (Spring)

- CIVE 105 Mechanics 2
- ENVE 121 Computational Methods
- ENVE 123 Electrical Circuits and Instrumentation
- ENVE 153 Earth Engineering
- MATH 118 Calculus 2 for Engineering

Term 2A (Winter)

- ENVE 223 Differential Equations and Balance Laws
- ENVE 224 Probability and Statistics
- ENVE 275 Environmental Chemistry
- ENVE 280 Fluid Mechanics
- ENVE 298 Seminar
- ERS 215 Environmental and Sustainability Assessment 1 (List A-Impact Courses CSE)

Term 2B (Fall)

- BIOL 240 Fundamentals of Microbiology
- ENVE 225 Environmental Modelling
- ENVE 277 Air Quality Engineering
- ENVE 279 Energy and the Environment
- ENVE 299 Seminar
- ENVE 382 Hydrology and Open Channel Flow
- WKRPT 200 Work-term Report

Term 3A (Spring)

- EARTH 458 Physical Hydrogeology
- EARTH 458L Field Methods in Hydrogeology
- ENVE 330 Lab Analysis and Field Sampling Techniques
- ENVE 375 Physico-Chemical Processes
- ENVE 392 Economics and Life Cycle Cost Analysis (List B-Engineering Economics CSE)
- ENVE 398 Seminar
- GEOE 353 Geotechnical Engineering 1
- WKRPT 300 Work-term Report

Term 3B (Winter)

- ENVE 335 Decision Making for Environmental Engineers
- ENVE 376 Biological Processes
- ENVE 383 Advanced Hydrology and Hydraulics
- ENVE 391 Law and Ethics for Environmental and Geological Engineers (List D-Other CSE)
- ENVE 399 Seminar
- TE 1 Approved Technical Elective

Term 4A (Fall)

- ENVE 400 Environmental Engineering Design Project 1
- ENVE 498 Seminar
- TE 2 Approved Technical Elective
- TE 3 Approved Technical Elective
- TE 4 Approved Technical Elective
- CSE 1 Approved Complementary Studies Elective
- WKRPT 400 Work-term Report

Term 4B (Winter)

- ENVE 401 Environmental Engineering Design Project 2
- ENVE 499 Seminar
- TE 5 Approved Technical Elective
- TE 6 Approved Technical Elective
- TE 7 Approved Technical Elective
- CSE 2 Approved Complementary Studies Elective

Electives

Students are responsible for selecting their own combination of electives, in keeping with their ultimate career objectives after graduation. The combination must satisfy the requirements of the Department of Civil and Environmental Engineering (CEE), which meet engineering accreditation requirements such that students are eligible to count their undergraduate education towards a professional engineering license. This includes having to meet minimum requirements in mathematics, natural sciences, engineering sciences, engineering design, and complementary studies.

Exceptions to courses on the Faculty of Engineering CSE lists and the Environmental Engineering TE and Specialization Lists require the approval of the CEE associate chair undergraduate studies. Some courses of interest may require prerequisite knowledge that is not part of the core curriculum in Environmental Engineering. Students may require extra courses or may need to seek enrolment approval from the course instructor if the prerequisites have not been satisfied.

Complementary Studies Electives

All engineering students are required to take complementary studies electives (CSEs), as described in Complementary Studies Requirements for Engineering Students. Two complementary studies elective courses in approved non-technical subjects must be taken. The CSEs are in addition to those courses which are part of the core curriculum and contain complementary studies material, such as ENGL 191/SPCOM 191 (List D), ERS 215 (List A), ENVE 391 (List D), and ENVE 392 (List B).

The two CSE courses must be chosen from List C-Humanities and Social Sciences Courses.

Technical Electives

Students are required to complete seven technical elective (TE) courses with the following restrictions:

- At least four TEs must be from TE List A (Engineering Design Intensive Technical Electives)
- The remaining three TEs may be from TE List A or B

The Technical Elective Lists for Environmental Engineering are provided below. Note that the offering of these courses is contingent upon sufficient demand and/or available teaching resources. There may be courses added and changes made to the content, term of offering, or meet times from what is listed below. Special Topics Courses (ENVE 495 and ENVE 497) are offered as resources and faculty availability permit. Further information is available from the CEE Undergraduate Office or CEE website.

Legend for TE List A and B

Term courses are offered: F=fall term, W=winter term, S=spring term

TE List A - Engineering Design Intensive Technical Electives

Choose at least four

- CHE 361 Bioprocess Engineering (F,W)
- CHE 514 Fundamentals of Petroleum Production (F)
- CHE 516 Energy Systems Engineering (F)

- CHE 571 Industrial Ecology (F)
- CHE 572 Air Pollution Control (W)
- CHE 574 Industrial Wastewater Pollution Control (W)
- CIVE 241 Transport Principles and Applications (F)
- CIVE 341 Transportation Engineering Applications (W)
- CIVE 495 Design Intensive Special Topics in Civil Engineering (as offered)
- EARTH 438 Engineering Geology (W)
- ENVE 495 Design Intensive Special Topics in Environmental Engineering (as offered)
- ENVE 577 Engineering for Solid Waste Management (W)
- ENVE 583 Design of Urban Water Systems (W)
- GEOE 354 Geotechnical Engineering 2 (F)
- GEOE 554 Geotechnical Engineering 3 (W)
- ME 452 Energy Transfer in Buildings (W)
- ME 571 Air Pollution (W)
- SYDE 532 Introduction to Complex Systems (W)
- SYDE 533 Conflict Resolution (F)
- SYDE 575 Image Processing (F)

TE List B - Technical Electives

Choose a maximum of three

- BIOL 354 Environmental Toxicology 1 (F,S)
- BIOL 364 Mathematical Modelling in Biology (F)
- BIOL 447 Environmental Microbiology (F)
- BIOL 455 Ecological Risk Assessment and Management (F)
- BIOL 462 Applied Wetland Science (F)
- BIOL 470 Methods of Aquatic Ecology (F)
- CHEM 237 Introductory Biochemistry (W,S)
- CHEM 262 Organic Chemistry for Engineering (F,W)
- CIVE 422 Finite Element Analysis (W)
- CIVE 440 Transit Planning and Operations (W)
- CIVE 507 Building Science and Technology (W)
- EARTH 221 Introductory Geochemistry (W,S)
- EARTH 342 Geomorphology and GIS Applications (F)
- EARTH 421 Advanced Geochemistry (F)
- EARTH 439 Flow and Transport Through Fractured Rocks (W)
- EARTH 440 Quaternary Geology (F)
- EARTH 444 Applied Wetland Science (F)
- EARTH 456 Numerical Methods in Hydrogeology (W)
- EARTH 459 Chemical Hydrogeology (W)
- ENVE 497 Special Topics in Environmental Engineering (as offered)
- ENVE 573 Contaminant Transport (W)
- GEOG 209 Hydroclimatology (W,S)
- GEOG 305 Fluvial Geomorphology (F)
- GEOG 371 Advanced Remote Sensing Techniques (F)
- GEOG 381 Advanced Geographic Information Systems (W,S)
- GEOG 409 Energy Balance Climatology (W)
- GEOG 471 Remote Sensing Project (W)
- ME 354 Thermodynamics 2 (W,S)
- ME 459 Energy Conversion (F,S)
- ME 559 Finite Element Methods (F,S)
- SYDE 411 Optimization and Numerical Methods (F)
- SYDE 531 Design Optimization Under Probabilistic Uncertainty (W)

Specializations

The Faculty of Engineering recognizes three specializations with the Environmental Engineering BASc degree. Students who satisfy the specialization requirements (courses and grades) will have the specialization designation shown on their transcript and diploma. Specializations are intended to recognize success in a concentration of electives within the Environmental Engineering degree specification. In other

words, specializations focus the selection of electives required for the base degree and do not require extra courses.

Each specialization requires students to select technical electives with a common theme. Students are responsible for meeting the TE requirements of the Environmental Engineering degree when pursuing a specialization. Each specialization requires the successful completion of a minimum number of TEs specified by the specialization with a minimum average of 60%. Students must declare a specialization for it to be recognized as part of their degree and appear on the transcript and diploma.

The specialization course requirements are provided below. Exceptions to the listed courses require the approval of the CEE associate chair, undergraduate studies.

Energy Specialization

The Energy Specialization requires a minimum of four TEs from the list below.

- From TE List A:
  - CHE 516 Energy Systems Engineering (F)
  - CIVE 495 Design Intensive Special Topics in Civil Engineering
    Topic: Building Energy Analysis (F,S), or
    Topic: HVAC Energy Efficiency (Low-Energy Building System) (W)
  - ME 452 Energy Transfer in Buildings (W)
- From TE List B:
  - CIVE 507 Building Science and Technology (W)
  - GEOG 409 Energy Balance Climatology (W)
  - ME 354 Thermodynamics 2 (W,S)
  - ME 459 Energy Conversion (F,S)

Hydrology Specialization

The Hydrology Specialization requires a minimum of four TEs from the list below.

- From TE List A:
  - ENVE 583 Design of Urban Water Systems (W)
  - SYDE 532 Introduction to Complex Systems (W)
  - SYDE 533 Conflict Resolution (F)
- From TE List B:
  - BIOL 470 Methods of Aquatic Ecology (F)
  - EARTH 439 Flow and Transport Through Fractured Rocks (W)
  - EARTH 444 Applied Wetland Science (F)
  - EARTH 459 Chemical Hydrogeology (W)
  - ENVE 573 Contaminant Transport (W)
  - GEOG 209 Hydroclimatology (W,S)
  - GEOG 305 Fluvial Geomorphology (F)
  - GEOG 371 Advanced Remote Sensing Techniques (F)
  - GEOG 381 Advanced Geographic Information Systems (W,S)

Pollution Treatment and Control Specialization

The Pollution Treatment and Control Specialization requires a minimum of four TEs from the list below.

- From TE List A:
  - CHE 361 Bioprocess Engineering (F,W)
  - CHE 571 Industrial Ecology (F)
  - CHE 572 Air Pollution Control (W)
  - CHE 574 Industrial Wastewater Pollution Control (W)
  - ENVE 577 Engineering for Solid Waste Management (W)
  - ME 571 Air Pollution (W)
- From TE List B:
  - ENVE 573 Contaminant Transport (W)

Geological Engineering

The Geological Engineering Academic Curriculum

A total of three approved Complementary Studies Electives (CSE), in addition to ENGL 191/SPCOM 191, GEOE 391, and GEOE 392, and six approved Technical Electives (TE) must be completed as detailed in the following sections.

Term 1A (Fall)

- CHE 102 Chemistry for Engineers
- CIVE 104 Mechanics 1
- ENGL 191/SPCOM 191 Communication in the Engineering Profession (List D-Other CSE)
- GEOE 100 Environmental and Geological Engineering Concepts
- GEOE 115 Linear Algebra
- MATH 116 Calculus 1 for Engineering

Term 1B (Spring)

- CIVE 105 Mechanics 2
- GEOE 121 Computational Methods
- GEOE 123 Electrical Circuits and Instrumentation
- GEOE 153 Earth Engineering
- MATH 118 Calculus 2 for Engineering

Term 2A (Winter)

- EARTH 238 Introductory Structural Geology
- GEOE 223 Differential Equations and Balance Laws
- GEOE 224 Probability and Statistics
- GEOE 280 Fluid Mechanics
- GEOE 298 Seminar
- CSE 1 Approved Complementary Studies Elective

Term 2B (Fall)

- CIVE 204 Solid Mechanics 1
- EARTH 231 Mineralogy
- EARTH 235 Stratigraphic Approaches to Understanding Earth's History
- EARTH 260 Introductory Applied Geophysics
- GEOE 221 Advanced Calculus
- GEOE 299 Seminar
- WKRPT 200 Work-term Report
- CSE 2 Approved Complementary Studies Elective

Term 3A (Spring)

- EARTH 232 Introductory Petrography
- EARTH 458 Physical Hydrogeology
- EARTH 458L Field Methods in Hydrogeology
- GEOE 353 Geotechnical Engineering 1
- GEOE 392 Economics and Life Cycle Cost Analysis (List B-Engineering Economics CSE)
- GEOE 398 Seminar
- WKRPT 300 Work-term Report
- TE 1 Approved Technical Elective

3A Technical Elective List

- CIVE 205 Solid Mechanics 2
- EARTH 221 Introductory Geochemistry

Term 3B (Winter)

- EARTH 333 Introductory Sedimentology
- EARTH 390 Methods in Geological Mapping (see Note)
- EARTH 437 Rock Mechanics
- EARTH 438 Engineering Geology
- ENVE 382 Hydrology and Open Channel Flow
- GEOE 399 Seminar
- CSE 3 Approved Complementary Studies Elective

Note: EARTH 390 is offered after winter term exams are finished in April. It is two weeks long, finishing before the spring term begins. Additional field trip fees will apply.

Term 4A (Fall)

- GEOE 354 Geotechnical Engineering 2
- GEOE 400 Geological Engineering Design Project 1
- GEOE 498 Seminar
- WKRPT 400 Work-term Report
- TE 2 Approved Technical Elective
- TE 3 Approved Technical Elective
- TE 4 Approved Technical Elective

4A Technical Elective List

- CHE 514 Fundamentals of Petroleum Production
- CIVE 306 Mechanics of Solids 3
- CIVE 310 Introduction to Structural Design
- CIVE 375 Environmental Engineering Principles
- EARTH 331 Volcanology and Igneous Petrology
- EARTH 342 Geomorphology and GIS Applications
- EARTH 421 Advanced Geochemistry
- EARTH 440 Quaternary Geology
- EARTH 444 Applied Wetland Science
- EARTH 461 Near-Surface Geophysics
- GEOE 495 Design Intensive Special Topics in Geological Engineering
- GEOE 497 Special Topics in Geological Engineering
- ME 559 Finite Element Methods

Term 4B (Winter)

- GEOE 391 Law and Ethics for Environmental and Geological Engineers (List D-Other CSE)
- GEOE 401 Geological Engineering Design Project 2
- GEOE 499 Seminar
- GEOE 554 Geotechnical Engineering 3
- TE 5 Approved Technical Elective
- TE 6 Approved Technical Elective

4B Technical Elective List

- CIVE 303 Structural Analysis
- CIVE 332 Civil Systems and Project Management
- CIVE 422 Finite Element Analysis
- CIVE 460 Engineering Biomechanics
- CIVE 507 Building Science and Technology
- CIVE 542 Pavement Structural Design
- EARTH 332 Metamorphic Petrology
- EARTH 435 Advanced Structural Geology
- EARTH 439 Flow and Transport Through Fractured Rocks
- EARTH 444 Applied Wetland Science
- EARTH 456 Numerical Methods in Hydrogeology
- EARTH 459 Chemical Hydrogeology
- EARTH 460 Geophysical Data Analysis
- EARTH 471 Mineral Deposits
- ENVE 383 Advanced Hydrology and Hydraulics
- ENVE 573 Contaminant Transport
- ENVE 577 Engineering for Solid Waste Management
- ENVE 583 Design of Urban Water Systems
- GEOE 495 Design Intensive Special Topics in Geological Engineering
- GEOE 497 Special Topics in Geological Engineering

Electives

Students are responsible for selecting their own combination of electives, in keeping with their ultimate career objectives after graduation. The combination must satisfy the requirements of the Department of Civil and Environmental Engineering (CEE), which meet engineering accreditation requirements such that students are eligible to count their undergraduate education towards a professional engineering license. This includes having to meet minimum requirements in mathematics, natural sciences, engineering sciences, engineering design, and complementary studies.

Exceptions to courses on the Faculty of Engineering CSE lists and the Geological Engineering TE and Specialization lists require the approval of the CEE associate chair undergraduate studies. Some courses of interest may require prerequisite knowledge that is not part of the core curriculum in Geological Engineering. Students may require extra courses or may need to seek enrolment approval from the course instructor if the prerequisites have not been satisfied.

Complementary Studies Electives

All engineering students are required to take complementary studies electives (CSEs), as described in Complementary Studies Requirements for Engineering Students. Three complementary studies elective courses must be taken in approved non-technical subjects. The CSEs are in addition to those courses which are part of the core curriculum and contain complementary studies material, such as ENGL 191/SPCOM 191 (List D), GEOE 391 (List D), and GEOE 392 (List B). The three CSE courses are to be chosen according to the following constraints:

- One course from List A-Impact Courses
- Two courses from List C-Humanities and Social Sciences Courses

Technical Electives

Students are required to complete six technical electives (TEs) by choosing from the 3A, 4A, and 4B TE lists provided above. Note that the offering of these courses is contingent upon sufficient demand and/or available teaching resources. There may be courses added and changes made to the content or term of offering from what is listed. Special Topics Courses (GEOE 495 and GEOE 497) are offered as resources and faculty availability permit. Further information is available from the CEE Undergraduate Office or CEE website.

Specializations

The Faculty of Engineering recognizes three specializations with the Geological Engineering BASc degree. Students who satisfy the specialization requirements (courses and grades) will have the specialization designation shown on their transcript and diploma. Specializations are intended to recognize success in a concentration of electives within the Geological Engineering degree specification. In other words, specializations focus the selection of electives required for the base degree and do not require extra courses.

Each specialization requires students to select technical electives with a common theme. Students are responsible for meeting the TE requirements of the Geological Engineering degree when pursuing a specialization. Each specialization requires the successful completion of a minimum number of TEs specified by the specialization with a minimum average of 60%. Students must declare a specialization for it to be recognized as part of their degree and appear on the transcript and diploma.

The specialization course requirements are provided below. Exceptions to the listed courses require the approval of the CEE associate chair, undergraduate studies.

Geology Specialization

The Geology Specialization course requirements are:

- EARTH 221 Introductory Geochemistry (3A TE) and EARTH 471 Mineral Deposits (4B TE)
- At least two TEs from the list below.
    - From the 4A TE List:
        - EARTH 331 Volcanology and Igneous Petrology (F)
        - EARTH 332 Metamorphic Petrology (W)
        - EARTH 342 Geomorphology and GIS Application (F)
        - EARTH 421 Advanced Geochemistry (F)
    - From the 4B TE List:
        - EARTH 435 Advanced Structural Geology (W)

Hydrogeology Specialization

The Hydrogeology Specialization course requirements are:

- EARTH 221 Introductory Geochemistry (3A TE)

- At least three TEs from the list below.
  - From the 4A TE List (F):
    - EARTH 342 Geomorphology and GIS Applications
    - EARTH 421 Advanced Geochemistry
    - EARTH 440 Quaternary Geology
    - EARTH 444 Applied Wetland Science
    - EARTH 461 Near-Surface Geophysics
  - From the 4B TE List (W):
    - EARTH 439 Flow and Transport Through Fractured Rocks
    - EARTH 456 Numerical Methods in Hydrogeology
    - EARTH 459 Chemical Hydrogeology
    - EARTH 460 Geophysical Data Analysis
    - ENVE 383 Advanced Hydrology and Hydraulics

Soil, Rock and Structures Specialization

The Soil, Rock and Structures Specialization course requirements are:

- CIVE 205 Solid Mechanics 2 (3A TE)
- At least three TEs from the list below.
  - From the 4A TE List (F):
    - CIVE 306Mechanics of Solids 3
    - CIVE 310 Introduction to Structural Design
  - From the 4B TE List (W):
    - CIVE 303 Structural Analysis
    - CIVE 422 Finite Element Analysis or ME 559 Finite Element Methods (F,S; 4A TE List)
    - CIVE 542 Pavement Structural Design
    - EARTH 435 Advanced Structural Geology

Management Engineering

The Management Engineering Academic Curriculum

The term-by-term academic component of the curriculum is as follows:

Term 1A (Fall)

- CHE 102 Chemistry for Engineers (3 LEC,2 TUT)
- MSCI 100 Management Engineering Concepts (3 LEC,2 TUT,3 LAB)
- MATH 115 Linear Algebra for Engineering (3 LEC,2 TUT)
- MATH 116 Calculus 1 for Engineering (3 LEC,2 TUT)
- PHYS 115 Mechanics (3 LEC,2 TUT)

Term 1B (Winter)

- ENGL 192/SPCOM 192 Communication in the Engineering Profession (3 LEC)
- GENE 123 Electrical Circuits and Instrumentation (3 LEC,1 TUT,1.5 LAB)
- MSCI 100B Seminar (1 LEC)
- MSCI 121 Introduction to Computer Programming (3 LEC,2 TUT)
- MSCI 131 Work Design and Facilities Planning (3 LEC,1 TUT,1.5 LAB)
- MATH 118 Calculus 2 for Engineering (3 LEC,2 TUT)
- PHYS 125 Physics for Engineers (3 LEC,2 TUT)

Term 2A (Fall)

- MSCI 200A Seminar (1 LEC)
- MSCI 240 Algorithms and Data Structures (3 LEC,1 TUT)
- MSCI 251 Probability and Statistics 1 (3 LEC,1 TUT,1.5 LAB)
- MSCI 261 Engineering Economics: Financial Management for Engineers (3 LEC,1 TUT)
- MSCI 271 Advanced Calculus and Numerical Methods (3 LEC,2 TUT)
- Natural Science Elective (see Note 4)

Term 2B (Spring)

- MSCI 200B Seminar (1 LEC)
- MSCI 245 Databases and Software Design (3 LEC,1 TUT,1.5 LAB)
- MSCI 253 Probability and Statistics 2 (3 LEC,1 TUT, 1.5 LAB)

- MSCI 263 Managerial Economics (3 LEC,1 TUT)
- MSCI 331 Introduction to Optimization (3 LEC,1 TUT)
- Natural Science Elective (see Note 4)

Term 3A (Winter)

- MSCI 211 Organizational Behaviour (3 LEC)
- MSCI 300A Seminar (1 LEC)
- MSCI 334 Operations Planning and Inventory Control (3 LEC,1 TUT,1.5 LAB)
- MSCI 342 Principles of Software Engineering (3 LEC,3 LAB)
- MSCI 391 Work-term Report
- MSCI 431 Stochastic Models and Methods (3 LEC,1 TUT)
- Elective

Term 3B (Fall)

- MSCI 300B Seminar (1 LEC)
- MSCI 302 Engineering Design Methods (3 LEC,1 LAB)
- MSCI 332 Deterministic Optimization Models and Methods (3 LEC,1 TUT)
- MSCI 333 Simulation Analysis and Design (3 LEC,1 TUT,1.5 LAB)
- MSCI 343 Human-Computer Interaction (3 LEC,1 TUT,1.5 LAB)
- MSCI 392 Work-term Report
- Elective

Term 4A (Spring)

- MSCI 400A Seminar (1 LEC)
- MSCI 401 Management Engineering Design Project 1 (3 LEC,3 PRJ)
- MSCI 434 Supply Chain Management (3 LEC,1 TUT,1.5 LAB)
- MSCI 436 Decision Support Systems (3 LEC,1 TUT)
- MSCI 491 Work-term Report
- Two electives

Term 4B (Winter)

- MSCI 311 Organizational Design and Technology (3 LEC)
- MSCI 400B Seminar (1 LEC)
- MSCI 402 Management Engineering Design Project 2 (3 LEC,3 PRJ)
- Three electives

Notes

1. MSCI 401 and MSCI 402 may be replaced by GENE 403 and GENE 404.
2. Some of the elective courses have prerequisites that are not met by core courses in Management Engineering; see their course descriptions in the current Calendar before planning elective choices.
3. Course offerings may vary from term to term; check course offerings before planning elective choices.
4. If a student cannot find a natural science elective for this term, they may take another course towards their degree requirements with the permission of their academic advisor. Taking another course does not reduce the requirement of two natural science electives.

Rules Restricting Choice of the Nine Elective Courses

1. Six of the nine electives must be from the list of approved technical electives. Students can count other Engineering courses towards this requirement subject to associate chair approval.
2. One of the nine electives must be from List A of the Complementary Studies Requirements for Engineering Students, (i.e., a course on the impact of technology on society).
3. Two of the nine electives must be from the list of approved natural science electives. Students can count other natural science courses towards this requirement subject to associate chair approval.

Technical Electives with Large Engineering Science and Design Content

Note: F=fall term, W=winter term, S=spring term

Six courses from the following list:

- MSCI 433 Applications of Management Engineering (W)
- MSCI 435 Advanced Optimization Techniques (W)
- MSCI 446 Introduction to Machine Learning (W)
- MSCI 452 Decision Making Under Uncertainty (S)
- MSCI 531 Stochastic Processes and Decision Making (S)
- MSCI 541 Search Engines (F)
- MSCI 543 Analytics and User Experience (S)
- MSCI 546 Advanced Machine Learning (W)
- MSCI 551 Quality Management and Control (F)
- MSCI 555 Scheduling: Theory and Practice (W)
- MSCI 598 Special Topics in Management Engineering (F,W,S)

Complementary Studies Electives

All Engineering students are required to take complementary studies electives (CSEs) as described in Complementary Studies Requirements for Engineering Students. Most of these requirements are satisfied in the core curriculum: ENGL 192 or SPCOM 192, MSCI 211, MSCI 261, MSCI 263, MSCI 311, together with satisfactory evaluations on three work-term reports. The requirement for studies on the impact of technology on society is met by rule 2.

Natural Science Electives

Two courses from this list of natural science courses:

- BIOL 110, BIOL 120, BIOL 130, BIOL 150, BIOL 165, BIOL 211, BIOL 239, BIOL 240, BIOL 273
- CHE 161
- CHEM 262
- EARTH 121, EARTH 122, EARTH 123, EARTH 221
- ENVS 200
- PHYS 124, PHYS 175, PHYS 233, PHYS 275
- PSYCH 261
- SCI 238, SCI 250

Professional Development Courses

Professional development (PD) courses are required as described in the BASc and BSE Specific Degree Requirements section on Work Terms. Management Engineering students are also required to take PD 11 Processes for Technical Report Writing and PD 22 Professionalism and Ethics in Engineering Practice. These courses replace two of the PD electives such that for Management Engineering students, PD 11 and PD 22 are additional core PD courses, and the number of PD electives required is reduced by two. Management Engineering students are automatically enrolled in the required core PD courses, PD 11 and PD 22, but must enrol in the elective.

Mechanical Engineering

The Mechanical Engineering Academic Curriculum

The Mechanical Engineering undergraduate curriculum contains a core of basic subjects that must be taken by all students. The second and third years provide courses in mechanical engineering and electrical engineering with further development in mathematics and physics. In fourth year, a significant two-term capstone design project will be undertaken that will facilitate and promote integration of the knowledge and skills acquired in previous years of study and development of project management skills. Opportunities for more in-depth study in theme areas exist during the fourth year, where a choice of technical elective courses arranged into five different theme areas of expertise is available. Students may also choose to take the Welding and Joining Specialization. Five required non-technical Complementary Studies Elective (CSE) courses are distributed throughout the curriculum but do not appear in all terms.

The following is the Mechanical Engineering core curriculum, excluding first year.

Credit Courses

- ME 201 Advanced Calculus
- ME 202 Statistics for Engineers
- ME 203 Ordinary Differential Equations
- ME 212 Dynamics
- ME 219 Mechanics of Deformable Solids 1
- ME 220 Mechanics of Deformable Solids 2
- ME 230 Control of Properties of Materials
- ME 250 Thermodynamics 1
- ME 262 Introduction to Microprocessors and Digital Logic

- ME 269 Electromechanical Devices and Power Processing
- ME 303 Advanced Engineering Mathematics
- ME 321 Kinematics and Dynamics of Machines
- ME 322 Mechanical Design 1
- ME 340 Manufacturing Processes
- ME 351 Fluid Mechanics 1
- ME 353 Heat Transfer 1
- ME 354 Thermodynamics 2
- ME 360 Introduction to Control Systems
- ME 362 Fluid Mechanics 2
- ME 380 Mechanical Engineering Design Workshop
- ME 481 Mechanical Engineering Design Project 1
- ME 482 Mechanical Engineering Design Project 2

Non-Credit Courses

- ME 200A and ME 200B Seminar
- ME 300A and ME 300B Seminar
- ME 400A and ME 400B Seminar

Note

In fourth year, a two-term Mechanical Engineering capstone design project must be undertaken under the auspices of ME 481 in the 4A term and ME 482 in the 4B term. This project may include involvement in either an inter-varsity student design competition team, or small group design project of the student's choosing.

Term-by-Term Curriculum

- Term 1A (Fall):
  - CHE 102, MATH 115, MATH 116, ME 100, PHYS 115
- Term 1B (Winter/Spring):
  - MATH 118, ME 100B, ME 101, ME 115, ME 123
  - One CSE
- Term 2A (Fall/Winter):
  - ME 200A, ME 201, ME 202, ME 219, ME 230, ME 269
  - One CSE
  - WKRPT 100 (stream 4)
- Term 2B (Fall/Spring):
  - ME 200B, ME 203, ME 212, ME 220, ME 250, ME 262
  - WKRPT 100 (stream 8) or WKRPT 200 (stream 4)
- Term 3A (Winter/Spring):
  - ME 300A, ME 303, ME 321, ME 340, ME 351, ME 354
  - WKRPT 200 (stream 8) or WKRPT 300 (stream 4)
- Term 3B (Fall/Winter):
  - ME 300B, ME 322, ME 353, ME 360, ME 362, ME 380
  - MSCI 261 or, if taken in Term 1B, one CSE
  - WKRPT 300 (stream 8)
- Term 4A (Fall/Spring):
  - ME 400A, ME 481
  - Three Technical Electives
  - One CSE
- Term 4B (Winter):
  - ME 400B, ME 482
  - Four Technical Electives
  - One CSE

Electives

Complementary Studies Electives

All Engineering students are required to take complementary studies electives (CSEs), as described in Complementary Studies Requirements for Engineering Students. Students entering this plan will take MSCI 261 - Engineering Economics: Financial Management for Engineers (a List B CSE course) plus four Complementary Studies Elective courses in other non-technical subjects. The grades obtained in these courses will be included in the calculation of term averages. Credit for an additional complementary studies elective is earned by obtaining satisfactory evaluations for the required work-term reports. These reports are based on work-term experience and are intended to develop skill in technical report writing; further information on work-term reports can be found in the section on Examinations and Promotions.

Technical Electives

Seven technical electives (TEs) are required in addition to the core courses listed above to fulfil the requirements of the Mechanical Engineering curriculum.

It is possible to combine courses from different theme areas or specialization, to take courses from other departments, and in some circumstances to take graduate-level courses. Students who are contemplating graduate study are particularly urged to discuss their study plans with a faculty member.

Students are responsible for selecting their own combination of electives, in keeping with their ultimate career objective after graduation. To assist in ensuring that course selections satisfy all academic requirements, students (as well as students who have an unusual career goal in mind) are encouraged to discuss and obtain approval by the Department of Mechanical Engineering's undergraduate advisor and/or the associate chair. Students may take any desired combination of technical electives or they may take a majority of their technical electives from one of the theme areas or specialization listed below.

As a guide, typical lists of technical elective courses for the five theme areas and the Welding and Joining Specialization within the Department of Mechanical and Mechatronics Engineering are given below. Students may take any desired combination of technical electives or they may choose to take a majority of their technical electives from one of the theme areas or specialization. Note that undergraduate students who complete the basic courses in each theme area or the Welding and Joining Specialization (see below) will be permitted and encouraged to take relevant Mechanical Engineering graduate courses in that area.

Automation and Control

- ME 435 Industrial Metallurgy
- ME 538 Welding Design, Fabrication and Quality Control
- ME 547 Robot Manipulators: Kinematics, Dynamics, Control
- ME 548 Numerical Control of Machine Tools 1
- ME 555 Computer-Aided Design
- ME 559 Finite Element Methods
- ME 561 Fluid Power Control Systems

Fluid Mechanics

- ME 562 Experimental Methods in Fluids
- ME 563 Turbomachines
- ME 564 Aerodynamics
- ME 566 Computational Fluid Dynamics for Engineering Design
- ME 567 Fire Safety Engineering
- ME 571 Air Pollution

Machine Design and Solid Mechanics

- ME 423 Mechanical Design 2
- ME 435 Industrial Metallurgy
- ME 524 Advanced Dynamics and Vibrations
- ME 526 Fatigue and Fracture Analysis
- ME 538 Welding Design, Fabrication and Quality Control
- ME 555 Computer-Aided Design
- ME 559 Finite Element Methods
- ME 574 Engineering Biomechanics

Materials Engineering and Processing

- ME 435 Industrial Metallurgy
- ME 436 Welding and Joining Processes
- ME 526 Fatigue and Fracture Analysis
- ME 531 Physical Metallurgy Applied to Manufacturing
- ME 533 Non-metallic and Composite Materials
- ME 535 Welding Metallurgy
- ME 538 Welding Design, Fabrication and Quality Control

Thermal Engineering

- ME 452 HVAC Load Analysis and Design Fundamentals
- ME 456 Heat Transfer 2
- ME 459 Energy Conversion
- ME 557 Combustion 1
- ME 559 Finite Element Methods
- ME 567 Fire Safety Engineering
- ME 571 Air Pollution
- ME 572 Building Energy Analysis
- ME 573 HVAC Systems, Equipment, and Energy Efficiency

Welding and Joining Specialization

Students may also choose to take the Welding and Joining Specialization. The normal sequence of courses for this specialization is outlined below.

Only Mechanical Engineering students may take the Welding and Joining Specialization. To earn the Welding and Joining Specialization designation, students must take five specific technical electives in their 4A and 4B terms: ME 435, ME 436, ME 526, ME 535, ME 538.

A minimum average of 60% in the five specialization courses and a minimum grade of 50% in each of the five courses is required. For students that take and meet the specialization requirements, the credential is recognized on both the diploma and the transcript.

Specialization Sequence

- Term 4A (Fall/Spring): ME 400A, ME 481, ME 435, ME 436, TE, one CSE
- Term 4B (Winter): ME 400B, ME 482, ME 526, ME 535, ME 538, TE, one CSE

Mechatronics Engineering

The Mechatronics Engineering Academic Curriculum

The table below lists the courses and technical electives for Mechatronics Engineering. In addition to the courses listed, all engineering students are required to take complementary studies courses, as described in Complementary Studies Requirements for Engineering Students. Also, see the technical elective list below.

The term-by-term sequence academic component of the curriculum is as follows:

Term 1A (Fall)

- CHE 102 Chemistry for Engineers (3 LEC,2 LAB)
- MATH 115 Linear Algebra for Engineering (3 LEC,2 LAB)
- MATH 116 Calculus 1 for Engineering (3 LEC,2 LAB)
- MTE 100 Mechatronics Engineering (3 LEC,2 TUT,4 LAB)
- MTE 121 Digital Computation (3 LEC,2 TUT)

Term 1B (Spring Stream 4/Winter Stream 8X)

- MATH 118 Calculus 2 For Engineering (3 LEC,2 LAB)
- MTE 100B Seminar (1 SEM)
- MTE 111 Structure and Properties of Materials (3 LEC,3 TUT,3 LAB)
- MTE 119 Statics (3 LEC,1 TUT)
- MTE 120 Circuits (4 LEC,2 TUT,1.5 LAB)
- MTE 140 Algorithms and Data Structures (3 LEC,1 TUT,1.5 LAB)

Term 2A (Winter Stream 4/Fall Stream 8X)

- MTE 200A Seminar (3 SEM)
- MTE 201 Experimental Measurement & Statistical Analysis (3 LEC,1 TUT,1 LAB)
- MTE 202 Ordinary Differential Equations (3 LEC,1 TUT)
- MTE 219 Mechanics of Deformable Solids (3 LEC,1 TUT)
- MTE 262 Introduction to Microprocessors and Digital Logic (3 LEC,1 TUT,3 LAB)
- SYDE 182 Physics 2 (Dynamics) (3 LEC,1 TUT)
- CSE Complementary Studies Elective
- WKRPT 100 (stream 4) Work-term Report

Term 2B (Fall Stream 4/Spring Stream 8X)

- MTE 200B Seminar (3 SEM)
- MTE 203 Advanced Calculus (3 LEC,1 TUT,1 LAB)
- MTE 204 Numerical Methods (3 LEC,1 TUT)
- MTE 220 Sensors and Instrumentation (3 LEC,1 TUT,3 LAB)
- MTE 241 Introduction to Computer Structures & Real-Time Systems (3 LEC,1 TUT,1.5 LAB)
- SYDE 252 Linear Systems and Signals (3 LEC,1 TUT)
- WKRPT 100 (stream 8X) or WKRPT 200 (stream 4) Work-term Report

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Term 3A (Spring Stream 4/Winter Stream 8X)

- MTE 300A Seminar (3 SEM)
- MTE 309 Introduction to Thermodynamics and Heat Transfer (3 LEC,1 TUT)
- MTE 320 Actuators and Power Electronics (3 LEC,1 TUT,2 LAB)
- MTE 321 Design and Dynamics of Machines (3 LEC,1 TUT)
- MTE 325 Microprocessor Systems and Interfacing for Mechatronics Engineering (3 LEC,1 TUT,1.5 LAB)
- SYDE 351 Systems Models 1 (3 LEC,1 TUT)
- WKRPT 200 (stream 8X) or WKRPT 300 (stream 4) Work-term Report

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Term 3B (Winter Stream 4/Fall Stream 8X)

- MTE 300B Seminar (3 SEM)
- ME 351 Fluid Mechanics 1 (3 LEC,1 TUT,1 LAB)
- MTE 322 Electromechanical Machine Design (3 LEC,1 TUT,2 LAB)
- MTE 360 Automatic Control Systems (3 LEC,1 TUT,1 LAB)
- MTE 380 Mechatronics Engineering Design Workshop (1 LEC,9 PRJ)
- MSCI 261 Engineering Economics: Financial Management for Engineers (3 LEC,1 TUT)
- CSE Complementary Studies Elective
- WKRPT 300 (stream 8) Work-term Report

Term 4A (Fall)

- ECE 484 Digital Control Applications (2 LEC,1 TUT,1.5 LAB)
- MTE 400A Seminar (1 SEM)
- MTE 481 Mechatronics Engineering Design Project (9 PRJ)
- CSE Complementary Studies Elective
- Two TE Technical Electives

Term 4B (Winter)

- MTE 400B Seminar (1 SEM)
- MTE 482 Mechatronics Engineering Project (9 PRJ)
- CSE Complementary Studies Elective
- Three TE Technical Electives

Complementary Studies Electives

Four of the five complementary studies electives (CSEs) are to be chosen to include at least one from List A and at least two from List C in the lists that are part of the description of Complementary Studies Requirements.

Technical Electives

The five technical electives (TEs) are to be chosen from the list below; in some cases, it may be necessary to verify that all of the prerequisites have been met. Note that courses are available in only one of the fourth-year terms. It is possible to exchange one of the fourth-year CSEs with a TE and thus have three technical electives in 4A (and two CSEs in 4B) or to have four technical electives in 4B (and two CSEs in 4A).

Courses Offered in the 4A (Fall) Term

Choose two:

- ME 362 Fluid Mechanics 2
- ME 436 Welding and Joining Processes
- ME 459 Energy Conversion
- ME 524 Advanced Dynamics and Vibrations or SYDE 553 Advanced Dynamics
- ME 548 Numerical Control of Machine Tools 1
- ME 559 Finite Element Methods
- ME 561 Fluid Power Control Systems
- MTE 420 Power Electronics and Motor Drives or ECE 463 Design & Applications of Power Electronic Converters (offered Spring)
- MTE 421 Linear and Nonlinear Electronics
- MTE 460 Mechatronic System Integration
- MTE 544 Autonomous Mobile Robots
- MTE 545 Introduction to MEMS Fabrication
- SYDE 533 Conflict Resolution
- SYDE 543 Cognitive Ergonomics
- SYDE 556 Simulating Neurobiological Systems
- SYDE 575 Image Processing
- SYDE 584 Physiological Systems and Biomedical Design

Courses Offered in the 4B (Winter) Term

Choose three:

- ECE 327 Digital Hardware Systems
- ECE 358 Computer Networks
- ECE 457B Fundamentals of Computational Intelligence
- ECE 488 Multivariable Control Systems
- ME 452 Energy Transfer in Buildings
- ME 547 Robotic Manipulators: Kinematics, Dynamics, Control or ECE 486 Robotic Dynamics and Control
- ME 555 Computer-Aided Design
- ME 563 Turbomachines
- ME 564 Aerodynamics
- MTE 460 Mechatronic System Integration
- MTE 546 Multi-sensor Data Fusion
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 542 Interface Design
- SYDE 544 Biomedical Measurement and Signal Processing
- SYDE 548 User Centred Design Methods
- SYDE 572 Introduction to Pattern Recognition

Nanotechnology Engineering

The Nanotechnology Engineering Academic Curriculum

The curriculum in Nanotechnology Engineering consists of a set of core courses complemented by eight technical elective courses.

The normal recommended curriculum shown below typically involves a course load (excluding seminars) of five to six lecture courses per term. Permission from the associate director of nanotechnology engineering (students), will be required for departures from the normal load in any given term. Permission to carry more than the regular load in any given term will normally be approved only for students who have attained an 80% or higher average in the preceding term.

The sequence of co-op work terms for Nanotechnology Engineering students comprises of two four-month work terms following the 1B and 2A terms, and two eight-month work terms following the 2B and 3B terms. The Co-operative Education Program Regulations apply, as further described in the Engineering Work Terms section. Three credited work reports are required for graduation.

The promotion criteria used to determine progression through the Nanotechnology Engineering plan is described in the Engineering Examinations and Promotions section of this Calendar.

The term-by-term academic component of the curriculum is as follows:

Term 1A (Fall)

- MATH 117 Calculus 1 for Engineering (3 LEC,2 TUT)
- NE 100 Introduction to Nanotechnology Engineering (3 LEC,1 TUT,2 LAB)
- NE 101 Nanotechnology Engineering Practice (1 SEM)
- NE 109 Societal and Environmental Impacts of Nanotechnology (3 LEC,1 TUT)
- NE 111 Introduction to Programming for Engineers (2 LEC)
- NE 112 Linear Algebra for Nanotechnology Engineering (3 LEC,1 TUT)
- NE 121 Chemical Principles (3 LEC,1 TUT)

Term 1B (Winter)

- MATH 119 Calculus 2 for Engineering (3 LEC,2 TUT)
- NE 102B Nanotechnology Engineering Practice (1 SEM)
- NE 110 Introduction to Nanomaterials Health Risks (3 LEC)
- NE 113 Introduction to Computational Methods (3 LEC,1 TUT,2 LAB)
- NE 125 Introduction to Materials Science and Engineering (3 LEC,1 TUT)
- NE 131 Physics for Nanotechnology Engineering (4 LEC,1 TUT)
- NE 140 Linear Circuits (3 LEC,2 TUT,1.5 LAB)

Term 2A (Fall)

- NE 201A Nanotechnology Engineering Practice (1 SEM)
- NE 215 Probability and Statistics (3 LEC,1 TUT)
- NE 216 Advanced Calculus and Numerical Methods 1 (3 LEC,1 TUT,2 LAB)
- NE 220L Materials Science and Engineering Laboratory (1.5 LAB)
- NE 222 Organic Chemistry for Nanotechnology Engineers (3 LEC,1 TUT,1.5 LAB)
- NE 241 Electromagnetism (3 LEC,2 TUT,1.5 LAB)
- Undergraduate Communication Requirement

Term 2B (Spring)

- NE 202B Nanotechnology Engineering Practice (1 SEM)
- NE 217 Advanced Calculus and Numerical Methods 2 (3 LEC,1 TUT,2 LAB)
- NE 225 Structure and Properties of Nanomaterials (3 LEC,1 TUT)
- NE 226 Characterization of Materials (3 LEC,1 TUT)
- NE 226L Laboratory Characterization Methods (1.5 LAB)
- NE 242 Semiconductor Physics and Devices (3 LEC,2 TUT,1.5 LAB)
- NE 281 Biology for Nanotechnology Engineers (3 LEC,1 TUT,1.5 LAB)

Term 3A (Spring)

- MSCI 261 Engineering Economics: Financial Management for Engineers (3 LEC,1 TUT)
- NE 301A Nanotechnology Engineering Practice (1 SEM)
- NE 318 Continuum Mechanics for Nanotechnology Engineering (3 LEC,1 TUT)
- NE 320L Characterization of Materials Laboratory (1.5 LAB)
- NE 332 Quantum Mechanics (3 LEC,1 TUT)
- NE 333 Macromolecular Science (3 LEC,1 TUT)
- NE 343 Microfabrication and Thin-film Technology (3 LEC,1 TUT)

Term 3B (Fall)

- NE 302 Nanotechnology Engineering Practice (1 SEM)
- NE 307 Introduction to Nanosystems Design (2 LEC)
- NE 330L Macromolecular Science Laboratory (1.5 LAB)
- NE 334 Statistical Thermodynamics (3 LEC,1 TUT)
- NE 336 Micro and Nanosystem Computer-aided Design (3 LEC,1 TUT,1.5 LAB)
- NE 340L Microfabrication and Thin-film Technology Laboratory (1.5 LAB)
- NE 352 Surfaces and Interfaces (3 LEC)
- Two Technical Electives

Term 4A (Fall)

- NE 408 Nanosystems Design Project (10 PRJ)
- CSE Complementary Studies Elective
- Three Technical Electives
- Two senior laboratory course electives selected from:
  - NE 454A Nano-electronics Laboratory 1 (1.5 LAB)
  - NE 454B Nano-instrumentation Laboratory 1 (1.5 LAB)
  - NE 454C Nanobiosystems Laboratory 1 (1.5 LAB)
  - NE 454D Nanostructured Materials Laboratory 1 (1.5 LAB)

Term 4B (Winter)

- NE 409 Nanosystems Design Project and Symposium (10 PRJ)
- CSE Complementary Studies Elective
- Three Technical Electives
- Two senior laboratory course electives selected from:
  - NE 455A Nano-electronics Laboratory 2 (1.5 LAB)
  - NE 455B Nano-instrumentation Laboratory 2 (1.5 LAB)
  - NE 455C Nanobiosystems Laboratory 2 (1.5 LAB)
  - NE 455D Nanostructured Materials Laboratory 2 (1.5 LAB)

Complementary Studies Electives

All Engineering students are required to take complementary studies electives (CSEs), as described in Complementary Studies Requirements for Engineering Students. A total of five (CSEs), including the Undergraduate Communication Requirement, must be taken. Two of the CSE choices must be NE 109 and MSCI 261.

Undergraduate Communication Requirement

Strong communication skills are essential to academic, professional, and personal success. To satisfy the Undergraduate Communication Requirement, Nanotechnology Engineering students must successfully complete a foundational course on communication. This course is scheduled into the 2A term, must be completed prior to enrolling in the 3A term, and can be selected from the following list below. These courses cannot be taken online.

- ENGL 109 Introduction to Academic Writing
- ENGL 129R/EMLS 129R Written Academic English
- EMLS 101R Oral Communications for Academic Purposes
- EMLS 102R Clear Communication in English Writing
- SPCOM 100 Interpersonal Communication
- SPCOM 223 Public Speaking

Work-term Reports and Reflection Milestone

Reflection is an integral part of work-integrated learning. To achieve the Work-term Reports and Reflection Milestone, Nanotechnology Engineering students must complete four reflective reports. These reflective reports are to be associated with each work-term, and are to be submitted immediately following the work-term. Alternately, students can clear this requirement with credit in a PD course requiring a reflective report, with the approval of their academic advisor, and if that PD course was taken during the work term. Reflective reports are typically short, structured reports offering the opportunity to reflect on experience obtained in the context of their academic learning or work.

Students are also required to submit one technical communication report by taking PD 11 Processes for Technical Report Writing as one of their PD electives.

Technical Electives

The Nanotechnology Engineering plan may be divided broadly into four areas of concentration, identified herein as micro and nano-instrumentation, nano-electronics, nanobiosystems, and nanomaterials. A set of eight technical elective course choices is provided in the curriculum to enable students to focus upon at least two of these areas of concentration. Students may choose up to four courses from outside the Nanotechnology Engineering plan to complement their studies. Approved technical electives are listed below. For a list of courses available in a specific term, consult the nanotechnology engineering undergraduate co-ordinator. The associate director (program) has the right, where the number of students enrolled in a course at the end of the Course Selection Period is 10 or less, to cancel the course.

Note: For NE 453, more than one course may be offered simultaneously under this course number.

- NE 335 Soft Nanomaterials (3 LEC)
- NE 344 Electronic Circuits (3 LEC)
- NE 345 Photonic Materials and Devices (3 LEC)
- NE 353 Nanoprobing and Lithography (3 LEC)
- NE 381 Introduction to Nanoscale Biosystems (3 LEC)
- NE 451 Simulation Methods (3 LEC)
- NE 452 Special Topics in Nanoscale Simulations (3 LEC)
- NE 453 Special Topics in Nanotechnology Engineering (3 LEC)
- NE 459 Nanotechnology Engineering Research Project (9 PRJ)
- NE 461 Micro and Nano-instrumentation (3 LEC)
- NE 466 Tactile Sensors and Transducers(3 LEC)
- NE 471 Nano-electronics (3 LEC)
- NE 476 Organic Electronics (3 LEC)
- NE 481 Nanomedicine and Nanobiotechnology (3 LEC)
- NE 486 Biosensors (3 LEC)
- NE 487 Microfluidic and Nanobiotechnological Systems (3 LEC)
- NE 488 Biomaterials and Biomedical Design (3 LEC)
- NE 491 Nanostructured Materials (3 LEC)
- NE 496 Nanomaterials for Electrochemical Energy Systems (3 LEC)

Students may choose up to a maximum of four non-NE technical elective courses from the lists below.

List 1 - 200-level

Maximum of one technical elective from the following list.

- CHE 225 Strategies for Process Improvement and Product Development
- CIVE 204 Solid Mechanics 1
- ECE 222 Digital Computers
- ECE 224 Embedded Microprocessor Systems
- ECE 250 Algorithms and Data Structures
- ECE 252 Systems Programming and Concurrency
- ECE 254 Operating Systems and Systems Programming
- ECE 260 Electromechanical Energy Conversion
- ME 262 Introduction to Microprocessors and Digital Logic
- MSCI 240 Algorithms and Data Structures
- MSCI 245 Databases and Software Design
- MTE 241 Introduction to Computer Structures & Real-Time Systems
- MTE 262 Introduction to Microprocessors and Digital Logic
- SYDE 223 Data Structures and Algorithms

List 2 - Non-NE

- BME 386 The Physics of Medical Imaging
- BME 393 Digital Systems
- BME 550 Sports Engineering
- BME 587 Special Topics in Biomedical Signals
- CHE 331 Electrochemical Engineering
- CHE 361 Bioprocess Engineering
- CHE 480 Process Analysis and Design
- CHE 514 Fundamentals of Petroleum Production
- CHE 516 Energy Systems Engineering
- CHE 521 Process Optimization
- CHE 543 Polymer Production: Polymer Reaction Engineering
- CHE 571 Industrial Ecology
- CHE 572 Air Pollution Control
- CHE 574 Industrial Wastewater Pollution Control
- CIVE 310 Introduction to Structural Design
- CIVE 460 Engineering Biomechanics
- CIVE 512 Rehabilitation of Structures

- ECE 327 Digital Hardware Systems
- ECE 340 Electronic Circuits 2
- ECE 350 Real-Time Operating Systems
- ECE 356 Database Systems
- ECE 358 Computer Networks
- ECE 360 Power Systems and Smart Grids
- ECE 373 Radio Frequency and Microwave Circuits
- ECE 375 Electromagnetic Fields and Waves
- ECE 406 Algorithm Design and Analysis
- ECE 409 Cryptography and System Security
- ECE 416 Advanced Topics in Networking
- ECE 417 Image Processing
- ECE 423 Embedded Computer Systems
- ECE 444 Integrated Analog Electronics
- ECE 457A Co-operative and Adaptive Algorithms
- ECE 457B Fundamentals of Computational Intelligence
- ECE 459 Programming for Performance
- ECE 474 Radio and Wireless Systems
- ECE 477 Photonic Devices and Systems
- ECE 484 Digital Control Applications
- ECE 488 Multivariable Control Systems
- ME 340 Manufacturing Processes
- ME 435 Industrial Metallurgy
- ME 459 Energy Conversion
- ME 526 Fatigue and Fracture Analysis
- ME 531 Physical Metallurgy Applied to Manufacturing
- ME 533 Non-metallic and Composite Materials
- MSCI 331 Introduction to Optimization
- MSCI 332 Deterministic Optimization Models and Methods
- MSCI 342 Principles of Software Engineering
- MSCI 343 Human-Computer Interaction
- MSCI 431 Stochastic Models and Methods
- MSCI 432 Production and Service Operations Management
- MSCI 435 Advanced Optimization Techniques
- MSCI 446 Introduction to Machine Learning
- MSCI 452 Decision Making Under Uncertainty
- MTE 322 Electromechanical Machine Design
- MTE 325 Microprocessor Systems and Interfacing for Mechatronics Engineering
- MTE 360 Automatic Control Systems
- MTE 420 Power Electronics and Motor Drives
- MTE 544 Autonomous Mobile Robots
- MTE 545 Introduction to MEMS Fabrication
- SE 464 Software Design and Architectures
- SYDE 322 Software Design
- SYDE 334 Applied Statistics
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 531 Design Optimization Under Probabilistic Uncertainty
- SYDE 533 Conflict Resolution
- SYDE 542 Interface Design
- SYDE 543 Cognitive Ergonomics
- SYDE 544 Biomedical Measurement and Signal Processing
- SYDE 548 User Centred Design Methods
- SYDE 552 Computational Neuroscience
- SYDE 556 Simulating Neurobiological Systems
- SYDE 572 Introduction to Pattern Recognition
- SYDE 584 Physiological Systems and Biomedical Design

Software Engineering

The Honours Software Engineering plan leads to a Bachelor of Software Engineering (BSE) degree.

Admissions

The Software Engineering Board, in consultation with the faculties of Engineering and Mathematics and their admissions committees, determines the admission requirements for Software Engineering.

For details on admission information, see the Admissions section of this Calendar.

Options, Specializations, Minors, and Joint Honours

Software Engineering students are considered as both Mathematics and Engineering students, and can thus take advantage of degree enhancements available to students from either faculty. These enhancements take the form of additional plans such as options, specializations, minors, and joint honours.

Software Engineering students are eligible for either the Artificial Intelligence Option (Engineering) or the Artificial Intelligence Specialization (Computer Science), but cannot graduate with both degree enhancements. See the full list of Computer Science specializations or the full list of Options, Specializations and Electives for Engineering Students.

The following Mathematics Joint Honours plans are also approved as additional plans for BSE students:

- Joint Applied Mathematics
- Joint Combinatorics and Optimization
- Joint Pure Mathematics, and
- Joint Statistics

BSE students are not eligible to add Joint Computer Science (Bachelor of Mathematics), Joint Bachelor of Computer Science plans, or stand-alone BMath Honours plans from the Faculty of Mathematics. BSE students pursuing a Joint Honours plan are not required to satisfy the Table 2 Faculty Core Courses requirements in the degree requirements for all Mathematics students. These students are still required to fulfil all requirements for the BSE.

BSE students may be eligible to add other options, specializations, or minors in Mathematics, Engineering, or other faculties, subject to the approval of the Software Engineering associate director. Students should be aware that adding plans will constrain their choice of electives, and may require additional courses. Thus, it is advisable to start preparing for additional plans in the first and second years. Students should also consider the benefits of not adding plans, in that they are better able to personalize their curriculum if they have more flexibility in choosing their electives. Students interested in pursuing additional academic plans, see invalid credential combinations.

Software Engineering Awards

Students in the Bachelor of Software Engineering plan are eligible for Awards of Excellence in the Faculty of Mathematics. Students in the Bachelor of Software Engineering plan are eligible for Awards of Excellence in the Faculty of Engineering.

Honours Software Engineering

The Software Engineering plan is offered jointly by the David R. Cheriton School of Computer Science and the Department of Electrical and Computer Engineering; it is only offered in the co-operative 8-stream.

Students will be considered members of both the Faculty of Engineering and the Faculty of Mathematics, although for administrative purposes they will be registered officially in a separate unit. Students will be promoted based on the Examinations and Promotions rules used in the Faculty of Engineering. A non-voting representative from the Faculty of Mathematics will sit on the Engineering Examinations and Promotion Committee, to provide insight into the policies, philosophies, culture, and requirements that pertain to Mathematics students. The Software Engineering plan is also considered an Honours Mathematics plan for purposes of student access to Mathematics courses. The Software Engineering advisor will advise students on how to achieve their academic goals.

Legend for Study/Work Sequence Table

Key	Description
F,W,S	F=fall term, W=winter term, S=spring term
1,2,3,4 plus A or B	Denotes academic year and term.
WT	Denotes scheduled work terms.

Study/Work Sequence

Sequence	F	W	S	F	W	S	F	W	S	F	W	S	F	W
Stream 8	1A	1B	WT	2A	WT	2B	WT	3A	WT	3B	WT	4A	WT	4B

Academic Curriculum

The term-by-term academic component of the curriculum is as follows:

Term 1A (Fall)

- CS 137 Programming Principles (3 LEC,1 TUT,2 LAB)
- ECE 105 Classical Mechanics (3 LEC,1 TUT, 1.25 LAB)
- MATH 115 Linear Algebra for Engineering (3 LEC,2 TUT)
- MATH 117 Calculus 1 for Engineering (3 LEC,2 TUT)
- MATH 135 Algebra for Honours Mathematics (3 LEC,1 TUT)
- SE 101 Introduction to Methods of Software Engineering (1 SEM,2 LAB)

Term 1B (Winter)

- CS 138 Introduction to Data Abstraction and Implementation (3 LEC,1 TUT,2 LAB)
- ECE 106 Electricity and Magnetism (3 LEC,1 TUT,1.25 LAB)
- ECE 124 Digital Circuits and Systems (3 LEC,1 TUT,1.25 LAB)
- ECE 140 Linear Circuits (3 LEC,2 TUT,1.25 LAB)
- MATH 119 Calculus 2 for Engineering (3 LEC,2 TUT)
- SE 102 Seminar (1 SEM)

Term 2A (Fall)

- CHE 102 Chemistry for Engineers (see Note 7) (3 LEC,2 TUT)
- CS 241 Foundations of Sequential Programs (3 LEC,1 TUT,2 LAB)
- ECE 222 Digital Computers (3 LEC,1 TUT,1.25 LAB)
- SE 201 Seminar (1 SEM)
- SE 212 Logic and Computation (3 LEC,1 TUT)
- STAT 206 Statistics for Software Engineering (see Note 5) (3 LEC,1 TUT)
- Undergraduate Communication Requirement (see Note 6)

Term 2B (Spring)

- CS 240 Data Structures and Data Management (3 LEC,3 LAB)
- CS 247 Software Engineering Principles (3 LEC,1 TUT, 3 LAB-unscheduled)
- CS 348 Introduction to Database Management (3 LEC,1 LAB)
- ECE 192 Engineering Economics and Impact on Society (2 LEC,1 TUT)
- MATH 239 Introduction to Combinatorics (3 LEC,1 TUT)
- SE 202 Seminar (1 SEM)
- Elective (see Note 1)
- WKRPT 200 Work-term Report

Term 3A (Winter)

- CS 341 Algorithms (3 LEC,3 LAB)
- CS 349 User Interfaces (3 LEC,1 LAB-unscheduled)
- MATH 213 Signals, Systems, and Differential Equations (3 LEC,1 TUT)
- SE 301 Seminar (1 SEM)
- SE 350 Operating Systems (3 LEC,1 TUT,1.25 LAB)
- SE 465 Software Testing and Quality Assurance (3 LEC,1 TUT,3 LAB-unscheduled)
- Elective (see Notes 1 and 2)

Term 3B (Fall)

- CS 343 Concurrent and Parallel Programming (3 LEC,3 LAB)
- ECE 358 Computer Networks (3 LEC,1 TUT,1.25 LAB)
- SE 302 Seminar (1 SEM)
- SE 380 Introduction to Feedback Control (3 LEC,1 TUT,1.25 LAB)
- SE 390 Design Project Planning (2 LEC,2 PRJ,LAB-unscheduled)
- SE 464 Software Design and Architectures (3 LEC,1 TUT,3 LAB-unscheduled)
- Elective (see Notes 1 and 2)
- WKRPT 300 Work-term Report

Term 4A (Spring)

- SE 401 Seminar (1 SEM)
- SE 463 Software Requirements Specification and Analysis (3 LEC,1 TUT,3 LAB-unscheduled)

- SE 490 Design Project 1 (2 LEC,9 PRJ,LAB-unscheduled)
- Three Electives (see Notes 1 and 3)
- WKRPT 400 Work-term Report

Term 4B (Winter)

- SE 402 Seminar (1 SEM)
- SE 491 Design Project 2 (2 LEC,2 PRJ,LAB-unscheduled)
- Four Electives (see Notes 1 and 3)

Advanced Technical Electives

The three advanced technical electives (ATEs) comprise fourth-year CS or ECE course offerings. Students are advised to plan ahead when selecting ATEs. Most ATEs are not offered every term, and some ATEs have other ATEs as prerequisites. The academic advisors may approve other courses.

CS List

One of the following CS courses:

- CS 360 Introduction to the Theory of Computing
- CS 365 Models of Computation
- CS 370 Numerical Computation
- CS 371 Introduction to Computational Mathematics
- CS 442 Principles of Programming Languages
- CS 444 Compiler Construction
- CS 448 Database Systems Implementation
- CS 449 Human-Computer Interaction
- CS 450 Computer Architecture
- CS 451 Data-Intensive Distributed Computing
- CS 452 Real-time Programming
- CS 454 Distributed Systems
- CS 457 System Performance Evaluation
- CS 458 Computer Security and Privacy
- CS 462 Formal Languages and Parsing
- CS 466 Algorithm Design and Analysis
- CS 479 Neural Networks
- CS 480 Introduction to Machine Learning
- CS 484 Computational Vision
- CS 485 Statistical and Computational Foundations of Machine Learning
- CS 486 Introduction to Artificial Intelligence
- CS 487 Introduction to Symbolic Computation
- CS 488 Introduction to Computer Graphics
- CS 489 Advanced Topics in Computer Science

ECE List

One of the following ECE courses:

- ECE 313 Digital Signal Processing
- ECE 320 Computer Architecture
- ECE 327 Digital Hardware Systems
- ECE 340 Electronic Circuits 2
- ECE 409 Cryptography and System Security
- ECE 416 Advanced Topics in Networking
- ECE 417 Image Processing
- ECE 423 Embedded Computer Systems
- ECE 454 Distributed Computing
- ECE 455 Embedded Software
- ECE 457A Co-operative and Adaptive Algorithms
- ECE 457B Fundamentals of Computational Intelligence

- ECE 457C Reinforcement Learning
- ECE 458 Computer Security
- ECE 459 Programming for Performance
- ECE 481 Digital Control Systems
- ECE 486 Robot Dynamics and Control
- ECE 488 Multivariable Control Systems
- ECE 493 Special Topics in Electrical and Computer Engineering
- ECE 495 Autonomous Vehicles

One additional course from the CS and ECE Lists above, or from the Extended List below.

Extended List

- CO 331 Coding Theory
- CO 342 Introduction to Graph Theory
- CO 351 Network Flow Theory
- CO 353 Computational Discrete Optimization
- CO 367 Nonlinear Optimization
- CO 456 Introduction to Game Theory
- CO 481 Introduction to Quantum Information Processing
- CO 485 The Mathematics of Public-Key Cryptography
- CO 487 Applied Cryptography
- MSCI 343 Human-Computer Interaction
- MSCI 446 Introduction to Machine Learning
- MSCI 543 Analytics and User Experience
- MTE 544 Autonomous Mobile Robots
- MTE 546 Multi-Sensor Data Fusion
- SE 498 Advanced Topics in Software Engineering
- STAT 440 Computational Inference
- STAT 441 Statistical Learning - Classification
- STAT 442 Data Visualization
- STAT 444 Statistical Learning - Advanced Regression
- SYDE 533 Conflict Resolution
- SYDE 543 Cognitive Ergonomics
- SYDE 548 User-Centred Design Methods
- SYDE 552 Computational Neuroscience
- SYDE 556 Simulating Neurobiological Systems
- SYDE 575 Image Processing

Science Course Electives

Normally, the science course electives (SCEs) are in the natural sciences, chosen from the list below. Alternate courses may be chosen in consultation with the SE academic advisors.

Two of

- BIOL 110, BIOL 120, (BIOL 130 and BIOL 130L), BIOL 150, BIOL 165, BIOL 211, BIOL 239, (BIOL 240 and BIOL 240L), BIOL 241, BIOL 273, (BIOL 373 and BIOL 373L)
- CHE 161
- (CHEM 123 and CHEM 123L), CHEM 209, (CHEM 237 and CHEM 237L), CHEM 254, (CHEM 262 and CHEM 262L), CHEM 266, CHEM 356, CHEM 404
- EARTH 121, EARTH 122, EARTH 123, EARTH 221, EARTH 270, EARTH 281
- ECE 231, ECE 403, ECE 404, ECE 405
- ENVE 275
- ENVS 200
- NE 222
- PHYS 124, PHYS 175, PHYS 234, PHYS 263, PHYS 275, PHYS 280, PHYS 334, PHYS 335, PHYS 375, PHYS 380
- SCI 238, SCI 250

Linkage Electives

Three linkage electives (LEs) courses as specified below. Students should be aware that these courses may have enrolment limits, or may not fit their schedules.

One course on Societal Issues:

- CS 492, Complementary Studies Elective List A

One additional course on Humanities and Social Sciences:

- Complementary Studies Elective List C

One course on Communications (see Note 6)

- ENGL 109
- ENGL 119
- ENGL 129R/EMLS 129R
- ENGL 209
- ENGL 210E
- EMLS 101R
- EMLS 102R
- SPCOM 100
- SPCOM 223

Notes

1. There are 10 electives. These electives must include three Advanced Technical Electives, two Science Course Electives, and three Linkage Electives. For their remaining two electives, students may choose to take additional courses from the elective lists above or any other 0.5 credit course(s) for which they meet the requisites. Advanced Technical Electives may not be taken before the 3A term.
2. Students must take one elective in third year, but can choose to take it in either 3A or 3B. Students may take electives in both terms if they choose.
3. Students may choose to take three electives in 4A and four electives in 4B, instead of two in 4A and five in 4B.
4. Students enrolled in Software Engineering will only be permitted to use the WD and WF (see Grades for descriptions) provisions used in the Faculty of Mathematics to withdraw from extra courses taken above the degree requirements.
5. Students may replace STAT 206 and one of their unrestricted electives with the combination of STAT 230 and STAT 231.
6. The linkage elective on communication (Undergraduate Communication Requirement) is normally taken in the 2A term. It must be completed with a grade of at least 60% prior to enrolling in the 3A term.
7. CHE 102 is treated as an elective for the purpose of reduced load; that is, students may take CHE 102 either before or after their 2A term. Students may take CHEM 120 instead of CHE 102.

Undergraduate Communication Requirement

Strong communication skills are essential to academic, professional, and personal success. As such, Software Engineering students must take a course from the Linkage Elective Undergraduate Communication Requirement List in the 2A term. This elective list is intended to include all of Mathematics Undergraduate Communication Requirement List 1, and selections from Mathematics Undergraduate Communication Requirement List 2. Communication skills are further developed and evaluated in three work-term reports (described below) and in SE 101, SE 390, SE 490, and SE 491.

Three Work-term Reports

Work-term reports (WKRPTs) are listed as part of the Software Engineering curriculum; they are treated as courses that a BSE student must successfully complete to satisfy the plan requirements. They appear on all grade reports and transcripts, but they are not used in calculating term averages.

Each work-term report requirement is satisfied by earning a grade of satisfactory or better on a work-term report related to the previous term's co-op employment. Each work-term report must be submitted at the beginning of the academic term in which it is listed as a course; it is due seven days after the first official day of lectures. Reports submitted after the due date will receive a failing grade and will be evaluated the following academic term.

Failed work-term reports contribute to a student's accumulated failed-course count. They also appear on a student's transcript. Once a failure has cleared, the original grade will still be listed on the transcript but will be annotated with a credit (CR) in the "sup" field.

Professional Development Courses

Five professional development (PD) courses are required as described in the BASc and BSE specific degree requirements section on Work Terms. Two core PD courses are specified for all engineering students: PD 19

and PD 20. Due to the importance of understanding the legal and ethical ramifications of software development, Software Engineering students are also required to take PD 10. This course replaces one of the PD electives, such that Software Engineering students have three core PD courses (PD 10, PD 19, and PD 20) and two PD elective courses. Software Engineering students are automatically enrolled in PD 10, PD 19, and PD 20 but must enrol in the elective PD courses using the normal Quest enrolment process.

Systems Design Engineering

The Systems Design Engineering Academic Curriculum

The Systems Design curriculum consists of two course groupings:

1. Compulsory core courses that prepare the student for practice in engineering and comprise 70% to 80% of the course load.
2. Elective courses that comprise 20% to 30% of the course load.

The following is the current core course curriculum with the course weight shown in square brackets [ ] next to each course. For those students who began in an earlier year, consult an earlier Calendar. Students should contact the Systems Design Engineering website for more details on the transition.

Term 1A (Fall)

- SYDE 101 [0.25] Communications in Systems Design Engineering-Written and Oral
- SYDE 101L [0.25] Communications in Systems Design Engineering-Visualization
- SYDE 111 [0.50] Calculus 1
- SYDE 113 [0.25] Elementary Engineering Math
- SYDE 121 [0.50] Digital Computation
- SYDE 161 [0.50] Introduction to Design
- SYDE 181 [0.50] Physics 1 (Statics)

Term 1B (Spring)

- SYDE 102 [0.00] Seminar
- SYDE 112 [0.50] Calculus 2
- SYDE 114 [0.25] Matrices and Linear Systems
- SYDE 162 [0.50] Human Factors in Design
- SYDE 192 [0.50] Digital Systems
- SYDE 192L [0.25] Digital Systems Laboratory
- SYDE 223 [0.50] Data Structures and Algorithms
- One Complementary Studies Elective

Term 2A (Winter)

- SYDE 201 [0.00] Seminar
- SYDE 182 [0.50] Physics 2 (Dynamics)
- SYDE 211 [0.50] Calculus 3
- SYDE 261 [0.50] Design, Systems, and Society
- SYDE 263 [0.25] Engineering Prototyping
- SYDE 283 [0.50] Physics 3 (Electricity, Magnetism and Optics)
- SYDE 285 [0.50] Materials Chemistry

Term 2B (Fall)

- SYDE 202 [0.00] Seminar
- SYDE 212 [0.50] Probability and Statistics
- SYDE 252 [0.50] Linear Systems and Signals
- SYDE 262 [0.50] Engineering Economics of Design
- SYDE 286 [0.50] Mechanics of Deformable Solids
- SYDE 292 [0.50] Circuits, Instrumentation, and Measurements
- SYDE 292L [0.25] Circuits, Instrumentation, and Measurements Laboratory
- WKRPT 200 [0.13] Work-term Report

Term 3A (Spring)

- SYDE 301 [0.00] Seminar
- SYDE 311 [0.50] Advanced Engineering Math 2
- SYDE 351 [0.50] Systems Models 1

- SYDE 361 [0.50] Systems Design Methods 1: Needs Analysis and Prototyping
- SYDE 381 [0.50] Thermodynamics
- SYDE 383 [0.50] Fluid Mechanics
- WKRPT 300 [0.13] Work-term Report

Term 3B (Winter)

- SYDE 302 [0.00] Seminar
- SYDE 312 [0.50] Applied Linear Algebra
- SYDE 352 [0.50] Introduction to Control Systems
- SYDE 352L [0.25] Control Systems Laboratory
- SYDE 362 [0.50] Systems Design Methods 2: Testing, Verification, and Validation
- One Technical Elective
- One Complementary Studies Elective

Term 4A (Fall)

- SYDE 401 [0.00] Seminar
- SYDE 411 [0.50] Optimization and Numerical Methods
- SYDE 461 [0.50] Systems Design Capstone Project 1
- Two Technical Electives
- One Technical or Complementary Studies Elective
- WKRPT 400 [0.13] Work-term Report

4B (Winter)

- SYDE 402 [0.00] Seminar
- SYDE 462 [0.50] Systems Design Capstone Project 2
- Three Technical Electives
- One Complementary Studies Elective

Canadian Engineering Accreditation Board (CEAB) Requirements

To determine the suitability of elective courses, students should complete the CEAB planner located on the Systems Design Engineering website. In addition to meeting CEAB requirements, the student's course selections (as reported in their planner) should be logical and defensible. Two CEAB planners must be completed and submitted to the associate chair for undergraduate studies, one planner for approval purposes in the student's 3A term, and one planner for graduation purposes at the end of the student's 4A term.

Students with combinations of electives that result in a plan that does not meet the CEAB criteria will not be permitted to graduate.

Complementary Studies Electives

In addition to the two courses in the core curriculum (SYDE 261 and SYDE 262), at least four elective courses must be chosen to satisfy the Complementary Studies Requirements for Engineering Students. Only courses noted in Lists A, B, C, and D are Faculty-approved complementary studies elective courses. Students may arrange the sequencing of the complementary studies elective courses to suit their academic plan (and any course prerequisites).

Technical Electives

Students must complete a minimum of six department-approved technical electives (TEs) to meet graduation requirements. Students may arrange the sequencing of the technical elective courses to suit their plan (and any course prerequisites).

The Department of Systems Design Engineering offers a wide variety of technical elective courses in the third and fourth year. Students are encouraged to design their own elective package to develop expertise in their particular interest area (see the Technical Elective Package section below). Approved technical elective courses are available from Systems Design Engineering, from other Engineering departments, and from a wide list of technical courses in the faculties of Science and Mathematics. Only courses from Engineering and Computer Science will contribute towards CEAB hours in the categories of "Engineering Science" and "Engineering Design." Some examples are listed below.

Biomedical Engineering

- BME 499 Elective Biomedical Research Project
- BME 550 Sports Engineering

- BME 551 Biomechanics of Human Movement
- BME 581 Ultrasound in Medicine and Biology
- BME 587 Special Topics in Biomedical Signals
- BME 588 Special Topics in Biomechanics
- BME 589 Special Topics in Biomedical Devices

Civil Engineering

- CIVE 440 Transit Planning and Operations
- CIVE 460 Engineering Biomechanics

Electrical and Computer Engineering

- ECE 254 Operating Systems and Systems Programming
- ECE 356 Database Systems
- ECE 358 Computer Networks
- ECE 406 Algorithm Design and Analysis
- ECE 457B Fundamentals of Computational Intelligence
- ECE 459 Programming for Performance
- ECE 484 Digital Control Applications

Management Sciences

- MSCI 343 Human-Computer Interaction
- MSCI 432 Production and Service Operations Management
- MSCI 446 Introduction to Machine Learning
- MSCI 555 Scheduling: Theory and Practice

Mechanical Engineering

- ME 321 Kinematics and Dynamics of Machines
- ME 574 Engineering Biomechanics

Mechatronics Engineering

- MTE 241 Introduction to Computer Structures & Real-Time Systems
- MTE 325 Microprocessor Systems and Interfacing for Mechatronics Engineering
- MTE 544 Autonomous Mobile Robots

Systems Design Engineering

- SYDE 322 Software Design
- SYDE 334 Applied Statistics
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 531 Design Optimization Under Probabilistic Uncertainty
- SYDE 532 Introduction to Complex Systems
- SYDE 533 Conflict Resolution
- SYDE 542 Interface Design
- SYDE 543 Cognitive Ergonomics
- SYDE 544 Biomedical Measurement and Signal Processing
- SYDE 548 User Centred Design Methods
- SYDE 552 Computational Neuroscience
- SYDE 553 Advanced Dynamics
- SYDE 556 Simulating Neurobiological Systems
- SYDE 572 Introduction to Pattern Recognition
- SYDE 575 Image Processing
- SYDE 584 Physiological Systems and Biomedical Design
- SYDE 599 Special Topics in Systems Design Engineering

Technical Elective Packages

The Department has identified four technical elective areas within its current offerings. Additional information regarding elective packages may be obtained from the associate chair for undergraduate studies. Students may choose a technical elective package from the four areas identified below to help them in their selection of technical electives. Choosing a specific elective package is not mandatory. Students do not receive any official notification on their transcript for completing an elective package.

Human Systems Engineering

The elective courses in this package are as follows:

3B (Winter)

- SYDE 544 Biomedical Measurement and Signal Processing
- SYDE 548 User Centred Design Methods

4A (Fall)

- SYDE 543 Cognitive Ergonomics
- SYDE 575 Image Processing
- SYDE 584 Physiological Systems and Biomedical Design

4B (Winter)

- SYDE 542 Interface Design
- SYDE 544 Biomedical Measurement and Signal Processing
- SYDE 572 Introduction to Pattern Recognition

Intelligent Systems
The elective courses in this package are as follows:

3B (Winter)

- SYDE 322 Software Design
- SYDE 531 Design Optimization Under Probabilistic Uncertainty
- SYDE 544 Biomedical Measurement and Signal Processing
- SYDE 552 Computational Neuroscience
- SYDE 572 Introduction to Pattern Recognition

4A (Fall)

- SYDE 543 Cognitive Ergonomics
- SYDE 556 Simulating Neurobiological Systems
- SYDE 575 Image Processing

4B (Winter)

- SYDE 522 Foundations of Artificial Intelligence
- SYDE 531 Design Optimization Under Probabilistic Uncertainty
- SYDE 544 Biomedical Measurement and Signal Processing
- SYDE 548 User Centred Design Methods
- SYDE 552 Computational Neuroscience
- SYDE 572 Introduction to Pattern Recognition

Societal and Environmental Systems
Note: Additional experience can be gained by doing related workshop projects in SYDE 362, SYDE 461, and SYDE 462.

The elective courses in this package are as follows:

3B (Winter)

- SYDE 334 Applied Statistics
- SYDE 531 Design Optimization Under Probabilistic Uncertainty
- SYDE 532 Introduction to Complex Systems
- SYDE 572 Introduction to Pattern Recognition

4A (Fall)

- SYDE 533 Conflict Resolution
- SYDE 575 Image Processing

4B (Winter)

- SYDE 334 Applied Statistics
- SYDE 522 Foundations of Artificial Intelligence
- SYDE 531 Design Optimization Under Probabilistic Uncertainty
- SYDE 532 Introduction to Complex Systems
- SYDE 572 Introduction to Pattern Recognition

Systems Modelling and Analysis
Note: The elective package structure is such that the students enrolled in this elective package can take additional courses, possibly from other departments, in order to focus in any specific engineering discipline and at the same time obtain a strong systems modelling and design foundation.

The elective courses in this package are as follows:

3B (Winter)

- SYDE 552 Computational Neuroscience
- SYDE 572 Introduction to Pattern Recognition

4A (Fall)

- SYDE 553 Advanced Dynamics
- SYDE 556 Simulating Neurobiological Systems
- SYDE 575 Image Processing
- SYDE 584 Physiological Systems and Biomedical Design

4B (Winter)

- SYDE 532 Introduction to Complex Systems
- SYDE 552 Computational Neuroscience
- SYDE 572 Introduction to Pattern Recognition

School of Architecture: Honours Bachelor of Architectural Studies

The Bachelor of Architectural Studies Program of Study

The academic program in Architecture is intended to prepare students to become architects capable of practice within contemporary professional constraints and adaptation to a changing profession and to the society it serves.

Two academic programs of study make up the five years of architectural studies:

1. An honours four-year Bachelor of Architectural Studies (BAS) degree
    - Comprised of eight academic terms of study and six four-month co-op work terms leading to the degree Bachelor of Architectural Studies.
    - This degree, combined with a minimum cumulative average of 75%, indicates appropriate preparation for the degree Master of Architecture (MArch).
2. A Master of Architecture (MArch) degree
    - Comprised of a nominal one-year professional program of study (three subsequent academic terms).

Honours Bachelor of Architectural Studies

Theme Areas

Courses in the Bachelor of Architectural Studies (BAS) degree are arranged in five main thematic groups:

1. Design: The practice of design and the understanding of its theories and methods.
2. Visual and digital media: The use of creative and analytical tools and techniques.
3. Cultural history and theory: The understanding of cultural and historical forces shaping the built world.
4. Technology and environment: The understanding of materials and methods, building technologies, and environmental issues and systems critical to the making of architecture.
5. Urbanism and landscape: An introduction to urbanism and landscape and the organization of natural and human ecologies.

Professional Practice

Students gain invaluable architectural professional experience through the co-op program which integrates two years of alternating paid work terms into the pre-professional course of study. Through co-op, Architecture students expand their professional education and opportunities as they apply their knowledge and skills within architectural firms all over the world.

Academic Requirements and Program Sequence

Pre-Professional Architecture

Term 1A (Fall)

- ARCH 110 Visual and Digital Media 1 [0.50 unit] *(Visual and Digital Media)*
- ARCH 120 An Introduction to Architectural Ideas and Communications [0.50 unit] *(Cultural History and Theory)*
- ARCH 142 Introduction to Cultural History [0.50 unit] *(Cultural History and Theory)*
- ARCH 172 Building Construction 1 [0.50 unit] *(Technology and Environment)*
- ARCH 192 Design Studio [1.50 units] *(Design)*

Term 1B (Winter)

- ARCH 113 Visual and Digital Media 2 [0.50 unit] *(Visual and Digital Media)*
- ARCH 126 Environmental Building Design [0.50 unit] *(Technology and Environment)*
- ARCH 143 Settlements, Sanctuaries, and Cities [1.00 unit] *(Cultural History and Theory)*
- ARCH 173 Building Construction 2 [0.50 unit] *(Technology and Environment)*
- ARCH 193 Design Studio [1.50 units] *(Design)*

Term 2A (Fall)

- ARCH 212 Digital Fabrication [0.50 unit] *(Visual and Digital Media)*
- ARCH 246 Cultural Encounters 600-1600 [1.00 unit] *(Cultural History and Theory)*
- ARCH 260 Principles of Structures [0.50 unit] *(Technology and Environment)*
- ARCH 292 Design Studio [1.50 units] *(Design)*

Term 2B (Spring)

- ARCH 225 Theory and Design of the Contemporary Landscape [0.50 unit] *(Urbanism and Landscape)*
- ARCH 243 Indigenous Practices [0.50 unit] *(Cultural History and Theory)*
- ARCH 248 Cultural Encounters 1600-1914 [1.00 unit] *(Cultural History and Theory)*
- ARCH 276 Timber: Design, Structure and Construction [0.50 unit] *(Technology and Environment)*
- ARCH 293 Design Studio [1.50 units] *(Design)*

Term 3A (Winter)

- ARCH 327 Architecture of the Urban Environment [0.50 unit] *(Urbanism and Landscape)*
- ARCH 342 Modernisms: Local and Global [1.00 unit] *(Cultural History and Theory)*
- ARCH 362 Steel and Concrete: Design, Structure and Construction [0.50 unit] *(Technology and Environment)*
- ARCH 364 Building Science [0.50 unit] *(Technology and Environment)*
- ARCH 392 Design Studio [1.50 units] *(Design)*

Term 3B (Fall)

- ARCH 393 Option Design Studio [1.50 units] *(Design)*
- ARCH 442 Contemporary Architectural Theory [0.50 unit] *(Cultural History and Theory)*
- Two electives from: ARCH 510, ARCH 520, ARCH 540, ARCH 570, ARCH 580
- Open elective (any discipline)

Term 4A (Fall, Rome)

- ARCH 428 Rome and the Campagna (Rome) or ARCH elective [0.50 unit] *(Urbanism and Landscape)*
- ARCH 446 Italian Urban History (Rome) or ARCH elective [0.50 unit] *(Cultural History and Theory)*
- ARCH 449 The Development of Modern Italian Architecture (Rome) or ARCH elective [0.50 unit]
- ARCH 492 Design Studio [1.50 units] *(Design)*
- Three electives from: 400-level ARCH courses, ARCH 510, ARCH 520, ARCH 540, ARCH 570, ARCH 580

Term 4B (Spring)

- ARCH 463 Integrated Environmental Systems [0.50 unit] *(Technology and Environment)*
- ARCH 473 Technical Report [0.50 unit] *(Technology and Environment)*
- ARCH 493 Design Studio/ Comprehensive Building Design [1.50 units] *(Design)*
- One elective from: ARCH 510, ARCH 520, ARCH 540, ARCH 570, ARCH 580
- Open elective (any discipline) [0.50 unit]

Architecture Electives

The Architecture elective requirement gives students breadth of study and opportunities for research at the upper levels of the pre-professional program in relation to four curricular areas: cultural history and theory (ARCH 540), technology and environment (ARCH 570), visual and digital media (ARCH 510), and urbanism and landscape (ARCH 520), as well as race, equity, and environmental justice (ARCH 580). A minimum of three and up to four architecture electives must be taken over the course of the BAS program. A minimum of two electives in the 4A term will be taken as ARCH 400-level cultural history electives offered in Rome, or as alternate Architecture upper-level electives. A minimum of two electives will be taken from the 500-level series in the third and fourth years (3A, 3B, 4A, 4B) of the BAS program.

Open Electives

The open elective requirement gives students some breadth of studies related to their role as educated professionals in society. A minimum of one and up to two electives from any discipline must be completed to satisfy the open elective requirement. These courses can be taken in any semester in the second to fourth years (2B, 3A, 3B, 4A, 4B) of the BAS program.

Regulations, Examinations and Promotions

The Bachelor of Architectural Studies (BAS), Honours and the Master of Architecture (MArch) are separate degrees. Students will not be permitted to proceed to the MArch until all of the course requirements of the BAS are successfully completed. Students must also apply to the MArch and meet all graduate admission requirements to be admitted to the MArch program.

- Passing Requirements and Standing
- Academic Decisions
- Final Examinations
- Submission of Course Material
- Minors

Passing Requirements and Standing

In order to proceed unconditionally from one term to the next in the Bachelor of Architectural Studies (BAS), Honours, students must satisfy each of the following requirements:

1. Maintain a minimum cumulative overall average of 70% (calculated at the end of each term).
2. Pass the studio course.
3. Not fail more than 0.50 units or equivalent (excluding studio) in any single term.

Note: The standard minimum passing grade in each ARCH course is 50% with the following exceptions: the minimum passing grade is 60% for all studio courses (ARCH 192, ARCH 193, ARCH 292, ARCH 293, ARCH 392, ARCH 393, ARCH 492, and ARCH 493). Grades below the specified passing grade result in a course failure.

The School of Architecture reserves the right to recommend exceptional academic decisions for students who require exceptional consideration, the Examinations and Promotions Committee will be guided by the following:

- Students who satisfy at least two of the above passing requirements, 1, 2, and 3, in a given term may be permitted to continue conditionally in the academic program as outlined in Notes 1-5 in Academic Decisions.
- Promotions decisions for students who satisfy only one of the passing requirements in any given term will be made on an individual basis by the Examinations and Promotions Committee.
- Students who satisfy one or none of the above requirements in a given term will normally receive the decision Required to Withdraw.
- No supplemental examinations are given by the School of Architecture.
- If a student receives a Required to Withdraw or a May Not Proceed decision, they must withdraw from the Bachelor of Architectural Studies program for two academic terms.
- Generally, students wishing to graduate with a Bachelor of Architectural Studies must spend a minimum of two years, including their final year, in residence (full-time on campus). In this case the 4A Rome term qualifies as the program is offered within the University of Waterloo. This does not preclude special studies approved in advance. Architecture students who choose to undertake alternate studies to the Waterloo 4B term may not graduate with a BAS degree because of the residence requirements.

Standing

The numeric grade system in combination with course unit weighting, are used in the calculation of averages and standing in the School of Architecture.

Academic Decisions

The possible academic decisions and their effect on the student's progress in the program are as follows:

1. **Excellent Standing** - student has achieved a cumulative average of 80% or above and is allowed to proceed unconditionally to the next term.
2. **Good Standing** - student has achieved a cumulative average that falls between 75% and 79.9% and is allowed to proceed unconditionally to the next term.
3. **Satisfactory Standing** - student has achieved a cumulative average that falls between 70% and 74.9% and is allowed to proceed unconditionally to the next term.
4. **May Not Proceed** - the student may not proceed to the next academic term. In the case of a failed studio, the student must repeat and pass the studio prior to continuation in the program. In the case of other failed core courses, the student will be given an Academic Advice Hold and must make arrangements with the undergraduate officer to retake the core courses. In the case of incomplete courses, these must be completed before the standing decision will be changed.
5. **Required to Withdraw** - the student's registration in the Bachelor of Architectural Studies (BAS) program is revoked. Readmission is not possible for four academic terms following the term for which the decision applies. Students must apply to the program for readmission.
6. **Recommended for BAS Degree** - all requirements of the program have been successfully completed.
7. **Aegrotat** - added to academic decision one; proceed to next term. The student has adequate understanding of the material, but because of illness or other extenuating circumstances, normal evaluation for at least one course was not possible.
8. **Proceed on Probation** - a decision used in exceptional circumstances that allows the student to proceed to the next term. Continued progress in the program is contingent on satisfying conditions which may be prescribed as the terms of probation.

Notes

1. **Cumulative Average -** Students who fail to maintain the minimum cumulative overall average requirement but who satisfy the other two requirements will receive the academic decision May Not Proceed. At the discretion of the Examinations and Promotions Committee such students must raise their cumulative average to a minimum of 70% by repeating the term or by repeating courses which are detrimental to their average and/or by taking approved elective courses before enrolling in the next higher level core or studio courses. The minimum cumulative average must be attained within the next calendar year. Failing this, the student will be Required to Withdraw. Failure to maintain the minimum cumulative average of 70% by the end of the next higher level term will result in the academic decision Required to Withdraw.
2. **Term Decision -** The term decision is based on the previous term decision, the term average for the current term, and the number of courses with grades below 50. The term average is calculated using the weight of the course, the status of the course (e.g., DRNA) and the interpreted course grade. All grades above 32 are interpreted as the submitted grade. Courses with a submitted grade below 32 are interpreted for averaging purposes, as having a value of 32. Both the number of courses below 50 in the current term as well as the cumulative number of uncleared courses on a student's record can be part of the decision.
3. **Studio Courses -** Students who fail a studio course (ARCH 192, ARCH 193, ARCH 292, ARCH 293, ARCH 392, ARCH 393, ARCH 492, ARCH 493) but who satisfy the other requirements will receive the academic decision May Not Proceed. Such students must repeat and pass the studio course. Failure to pass the studio in question on the second attempt will result in the academic decision Required to Withdraw. Students may not register in any higher level studio course or core courses until the failed studio course is passed. Credit will be retained for courses passed in a term in which a studio course is failed.
4. **Elective Courses -** Students who fail more than one elective course or equivalent in any single term (but who pass studio and maintain the minimum cumulative overall average) will receive the academic decision Proceed on Probation. Failed elective courses or their equivalents must be repeated and passed by the end of the next term of study. Should the student fail more than one half-unit elective course or equivalent in the next term, the student will receive the academic decision Required to Withdraw.
5. **Core Courses and Accumulated Fail Counts -** Students who fail or achieve incomplete status in two or more core (non-studio) courses or equivalent in any single term, or who accumulate three or more failed or incomplete courses at any point in their degree (but who pass studio courses and maintain the minimum cumulative overall average), will receive the academic decision May Not Proceed. The failed courses or equivalent must be repeated and passed before the student may register in any higher-level studio or core courses. Should the student fail two or more courses or equivalent in the next term, the student will receive the academic decision Required to Withdraw.
6. **Conditional Status (Proceed on Probation) -** Notwithstanding the provisions of Notes 1 to 4, students who have been granted conditional status in a previous term during the course of the BAS, Honours academic program will be Required to Withdraw if at any subsequent time they fail to meet any one or more of the three basic requirements for unconditional promotion as stated in 1, 2, 3 under the Passing Requirements and Standing page.
7. **Incomplete Courses -** Students who receive the decision INC, see Grades for description of grades. To obtain credit for a core or elective course subsequently, the student must retake and register again for the course (or an approved equivalent). For an elective course, an alternative may be taken.
8. **Failed Courses -** When a course is repeated, both grades will appear on the student record and will be included in the calculation of the cumulative overall average. An exception applies to repeated core courses of greater than or equal to 1.0 credit weight. These will have the first failure removed from the average, however, the course attempt will be retained on the transcript.
9. **Course Loads -** Normally, students of the School of Architecture are permitted to take only one more or one fewer term courses than that prescribed for the particular year and term in which they are registered. Any further addition or reduction to the student's program must be approved by the undergraduate officer of the School of Architecture.
10. **Appeals and Petitions -** Refer to Policy 70-Student Petitions and Grievances, and Policy 72-Student Appeals, or in the Policies and Guidelines section of this Calendar.
11. **Letter of Permission -** Students may request to take a course(s) at other universities for credit towards a University of Waterloo degree by Letter of Permission. A Letter of Permission is granted only to students who have successfully completed a minimum of four University of Waterloo courses and who are in good standing; that is, they have satisfied the minimum cumulative average requirements for their current program. A maximum total of three courses may be taken on a Letter of Permission or by Cross-Registration with Wilfrid Laurier University or by enrolling in a Laurier

course that appears on the University of Waterloo Schedule of Classes.

Courses taken on a Letter of Permission must be approved in advance by the undergraduate officer and recorded by the Office of the Registrar. Such courses must be taken at a degree granting university. Credit for courses taken on a Letter of Permission will be granted only when the assigned grade is equivalent to at least 60% on the University of Waterloo grade scale.

Normally, courses considered by the Faculty of Engineering to be core or degree term requirements may not be taken on a Letter of Permission.

Wherever possible, courses taken on a Letter of Permission will be recorded as the equivalent University of Waterloo course and graded as per policy for the Faculty of Engineering.

12. **Transfer Credits -** Transfer credit may be given for courses in which a grade of 70% or better was obtained. Such courses must have been taken at a degree granting university. Application must be made to the undergraduate officer where transfer credits are desired as an exemption from required core courses.

    As the Bachelor of Architectural Studies, Honours Architecture academic program is included in the accreditation review of the professional Master of Architecture program by the Canadian Architectural Certification Board, absolute equivalency of courses for transfer credit must be determined. It is the student's responsibility to submit transcripts and full course outlines for assessment.
13. **Co-op Work-term Reports -** To be considered in good standing in Honours Co-operative programs, in addition to maintaining the required minimum cumulative averages, students must complete and submit satisfactory co-op work reports at the completion of each co-op work term. The normal date for submission is the end of the second week of classes of the following academic term. A minimum of three satisfactory work reports is required for the Bachelor of Architectural Studies, Honours co-op degree. Co-op work-term reports must be submitted prior to students being interviewed for their subsequent work-term opportunities. Students not meeting this requirement will not be included in the interview and job process for the subsequent term.

Final Examinations

1. In all courses, each student is required to submit (in such form and at such time as may be determined by the instructor) evidence of satisfactory participation. The grades obtained from work during the term are used in part in determining standing.
2. Failure to write an examination is ordinarily considered a failure to pass (a grade of 32). A student who defaults a final examination, except for a properly certified reason, shall have no make-up examination privileges and may be required to repeat the work in class. If a student fails to write for medical reasons, a doctor's certificate covering the precise period of absence must be filed in the Office of the Registrar within one week of the set examination date.
3. A student will be eligible for deferred examinations only when failure to pass is attributable to extraordinary circumstances. In addition, students:
    - must have attended a reasonable number of lectures in the course in which they propose to write, and must have satisfied all course work requirements;
    - must have secured the permission of the professor concerned.

Submission of Course Material

In situations where a student wishes to submit a body of material to satisfy the requirement of more than one course, and where the courses are concurrent, the student must notify the instructors of both courses of their intention so that they may each decide what is appropriate for their own course.

When one of the courses has been taken in a previous term, the current course instructor must be informed by the student of their intention of submitting the same course material. The current instructor has the final decision on the extent to which the material is allowed.

Failure of a student to comply with the above regulation constitutes an academic offence.

Minors

The Bachelor of Architectural Studies, Honours program does not offer a minor. Bachelor of Architectural Studies (BAS) students may take a minor with another program at the University. It will be the responsibility of the student to file a Plan Modification Form with the respective academic unit and ensure that course requirements are met. As most minors require 8-10 courses, and there are only six term course electives available in the Architecture program, students should expect to take additional time to

complete the degree. Students interested in pursuing additional academic plans, see invalid credential combinations.

Co-operative System of Study

The Bachelor of Architectural Studies, Honours Architecture academic program includes eight terms of study, six four-month co-op work terms (of which five are required to graduate), and one "off term." The work terms must be pre-approved by Co-operative Education.

Note

The "off term" in the Bachelor of Architectural Studies academic program follows the first two terms of study (from September to April) in Year One. Students may use the "off term" as a vacation period or they may seek employment. Any employment arrangements made for the "off term" are the student's own responsibility. If architecture related employment is obtained during the "off term" following 1B, it will not be considered as a replacement for any subsequent work term requirement.

Students wishing to take time off from school or going on an exchange opportunity must complete a Study/Work Sequence change form.

Although co-op begins in 2A, admission is made at the time of the initial application to the University.

Work-Term Reports

The work-term report (WKRPT) is intended to illustrate the understanding and experience that co-op students have acquired during employment and to record and assess their educational and work experience, tracked against two sets of criteria, the Student Performance Criteria established by the Canadian Architectural Certification Board and the Canadian Experience Record used by the provincial licensing bodies. To graduate with a Bachelor of Architectural Studies (BAS), Honours degree, a student must successfully complete three acceptable work reports as per the table showing the requirements below. If students do not secure work-term employment, they may still submit a work report for credit. The Faculty of Engineering must first approve the topic. The work report will be evaluated as a professional document. Each work report will be specific to the level of the work term. All work reports will be evaluated in the Faculty of Engineering, School of Architecture.

For more information on work report requirements, see the School of Architecture Co-op web page, under work reports, or contact the School's undergraduate student services co-ordinator.

Professional Development - Architecture

There are a total of five Professional Development courses, four Professional Development for Architecture (PDARCH) courses and one Professional Development course (PD), required for the Bachelor of Architectural Studies (BAS) degree. These courses are normally taken during work terms and students are expected to enrol in one such course each off term or work term until the requirement has been completed.

In the event that students have taken a PDARCH course in each work term, but have failed the most recent PDARCH course, students may request permission to repeat in a subsequent academic term the PDARCH course that was failed. Students should contact their academic advisors to determine if they qualify for this alternative. Failed PDARCH and PD courses contribute towards the accumulated fail count.

It is recommended that the PDARCH courses be taken in the sequence set out in the chart below. In the instance of the fifth Professional Development course, students are permitted to enrol in one of the following WatPD elective courses that deal with issues directly relevant to the architectural workplace: Communication (PD 3), Teamwork (PD 4), Project Management (PD 5), Problem Solving (PD 6), Conflict Resolution (PD 7), Intercultural Skills (PD 8), Ethical Decision Making (PD 9), Professional Responsibility in Computing (PD 10), or Critical Reflection for Growth in the Workplace (PD 12).

Sequence of Study/Work Terms and Co-op Requirements

Term	Work Report and Professional Development Requirements
1A Fall	Academic study
1B Winter	Academic study
Spring	PDARCH 1: Portfolio Development
2A Fall	Academic study PDARCH 2: Co-op Fundamentals for Architects
Co-op 1 Winter	PDARCH 3: Electronic Communications and Web Design
2B Spring	Academic study
Co-op 2 Fall	PDARCH 4: Writing, Editing and Research
3A Winter	Academic study
Co-op 3 Spring	Select one from: PD 3, PD 4, PD 5, PD 6, PD 7, PD 8, PD 9, PD 10, or PD 12 WKRPT 103 (Canadian Architectural Certification Board (CACB) Criteria)
3B Fall	Academic study
Co-op 4 Winter	WKRPT 203 (Firm Case Study)
Co-op 5 Spring	Not applicable
4A Fall	Academic study (Rome)
Co-op 6 Winter	WKRPT 303 (Canadian Experience Record Book)
4B Spring	Academic study

Professional Development courses are online offerings. It is the responsibility of students to ensure that they have adequate internet access during work terms to complete course requirements.

Architecture Admissions

The admission categories, requirements, and procedures of the University of Waterloo are outlined in detail in the Admissions section of this Calendar.

Course Requirements for Applicants

For up-to-date and detailed information of course requirements, see the School of Architecture Future undergraduate students web page.

The Admissions Process

Students wishing to apply to the School of Architecture will be initially screened on the basis of grades received in their required courses. By this process, approximately 450 students will be further considered for admission to the School of Architecture. These students are required to:

- Participate in an interview as part of the admissions process.
- Complete a test in the form of an English précis on the day of their scheduled interview.
- Present a portfolio of creative work must at the time of the interview.

Admission to the School depends equally on success in the précis test and the results of the interview. An Admissions Information Form is required.

With the high number of applications, students will normally need an overall average of 80%, a grade of at least 75% (usually 80%) in English, and at least low 70s in physics and the two required mathematics courses to be considered for an interview. If offered admission, a final grade of at least 70% (but 75% in English) in each required course is needed to maintain an offer of admission. It is recommended that students take art, history, and other creative courses. The admission requirements from other provinces and countries is available.

More information on the process, and portfolio requirements may be found on the School of Architecture website.

Accessing Incoming Transfer Credits

Generally, transfer credit can be given for courses completed at accredited post-secondary institutions in which a grade of 70% or better was obtained. Students transferring from other institutions may have their transferred courses count toward the University of Waterloo degree as determined by the undergraduate officer. Grades obtained in these courses will not be included in the calculation of the student's average. Transfer credit may be given towards elective course requirements, as well as, core courses for which a precise matching of content can be proven.

Incoming students wishing to receive credit for previous courses should contact the undergraduate officer to have their transcripts and course outlines reviewed. The actual assessment and agreement to transfer credits will only be completed for students who have been accepted into the program.

Students transferring from faculties within the University, or former University of Waterloo students returning after an absence, may transfer previous University of Waterloo courses with 60% or better to fulfil Honours Bachelor of Architectural Studies (BAS) program requirements, whether core or elective. Generally, the grades from these courses are not included in the cumulative average.

Advanced Standing Applicants

Students wishing to apply for advanced standing (e.g., those having partially completed a professional degree in architecture at another institution), must apply in writing to the undergraduate officer to initiate the process. The School of Architecture at the University of Waterloo will need copies of official transcripts and course outlines (fully translated), and samples of work to initiate the process. Transfer credits will only be assessed if an offer of admission is made. The applicant may be invited for an interview. Advanced standing applicants must also write the English précis test. Acceptances will depend on the quality of the applicants, as well as, space available.