Notice of Meeting

DATE: Tuesday 8 October 2019
TIME: 12:00 noon – 2:00 p.m.
PLACE: NH 3318

Please note:
A light lunch will be served.

Open Session

<table>
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<th>Item</th>
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<td>1. Declarations of Conflict of Interest - Excerpt from Senate Bylaw 1*</td>
<td>Info</td>
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<td>2. Approval of the 10 September 2019 Minutes* and Business Arising</td>
<td>UGC</td>
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<td>3. Curricular Items for Approval &amp; Information</td>
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<tr>
<td>a. Arts*</td>
<td>1 UGC</td>
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<tr>
<td>b. Engineering*</td>
<td>1.b. (option inactivations), III (new specializations) SEN-R; rest UGC</td>
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<tr>
<td>c. Environment*</td>
<td>3.a.i SEN-R; 4.a. SEN-C; rest UGC</td>
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<tr>
<td>d. Mathematics*</td>
<td>4 SEN-C; rest UGC</td>
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<tr>
<td>e. Science*</td>
<td>UGC</td>
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<tr>
<td>f. Software Engineering*</td>
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<td>4. Registrar’s Office</td>
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<td>a. Reading Week*</td>
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<td>a. Global Experience Certificate*</td>
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<td>6. Framework for the Assessment of Unauthorized Collaboration Involving Undergraduate Students*</td>
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<td>7. Academic Program Reviews</td>
<td>Information</td>
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<td>a. Academic Program Reviews - Status</td>
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<td>8. Other Business</td>
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<td>9. Next Meeting: Tuesday 12 November 2019, 12:00 to 2:00 p.m. in NH 3318</td>
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</tbody>
</table>

*material attached/to be distributed**
“SEN-C” to be recommended to Senate for approval (consent agenda)
“SEN-R” to be recommended to Senate for approval (regular agenda)
“UGC” to be approved on behalf of Senate & sent to Senate for information

1 October 2019
Rebecca Wickens
Associate University Secretary
## Excerpt from Senate Bylaw 1

### 8. Declarations of conflict of interest

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>8.01</strong></td>
<td>At the beginning of each meeting of Senate or any of Senate’s committees or councils, the chair will call for members to declare any conflicts of interest with regard to any agenda item. For agenda items to be discussed in closed session, the chair will call for declarations of conflict of interest at the beginning of the closed portion of the meeting. Members may nonetheless declare conflicts at any time during a meeting.</td>
</tr>
<tr>
<td><strong>8.02</strong></td>
<td>A member shall be considered to have an actual, perceived or potential conflict of interest, when the opportunity exists for the member to use confidential information gained as a member of Senate, or any of Senate’s committees or councils, for the personal profit or advantage of any person, or use the authority, knowledge or influence of the Senate, or a committee or council thereof, to further her/his personal, familial or corporate interests or the interests of an employee of the university with whom the member has a marital, familial or sexual relationship.</td>
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<tr>
<td><strong>8.03</strong></td>
<td>Members who declare conflicts of interest shall not enter into debate nor vote upon the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).</td>
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<tr>
<td><strong>8.04</strong></td>
<td>Where Senate or a committee or council of Senate is of the opinion that a conflict of interest exists that has not been declared, the body may declare by a resolution carried by two-thirds of its members present at the meeting that a conflict of interest exists and a member thus found to be in conflict shall not enter into debate on the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).</td>
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</tbody>
</table>
1. DECLARATIONS OF CONFLICTS OF INTEREST
No conflicts of interest were declared.

2. APPROVAL OF THE 18 JUNE 2019 MINUTES AND BUSINESS ARISING
The minutes were accepted as presented without formal motion. There was no business arising.

3. CURRICULAR ITEMS FOR APPROVAL & INFORMATION
   
   **Applied Health Sciences.** Following an overview by Ferries, there was a motion to recommend that Senate approve the new rehabilitation sciences specialization and related inactivation of the rehabilitation sciences minor as presented, effective 1 September 2020. Ferries and Vigna. Carried. Ferries presented the plan changes and new courses, following which there was an omnibus motion to approve those items on behalf of Senate. Ferries and Acheson. Carried.
   
   **Arts.** Following a brief description of the revision and rationale, there was a motion to approve the course change as presented, effective 1 September 2020. Acheson and Ferries. Carried.
   
   **Science.** Spafford took members through the new courses, course changes and inactivated courses, noting the new capstone courses, statistics course, and reactivations of certain chemistry courses and labs. There was a motion to approve the proposed new courses, course changes and inactivation of courses on behalf of Senate. Spafford and Dayeh. Carried.

Spafford spoke to the plan changes, highlighting: changes related to the creation of new courses, reactivations and inactivations presented in Section A of the science submission; the introduction of a 70% core average for honours co-operative medicinal chemistry due to the demanding nature of the program; the review of the materials and nanosciences programs, leading to a number of changes; the changes to all co-op plans except BSc psychology to reduce the number of required work term reports from four to three. Spafford also presented regulatory changes, including the previously mentioned changes to co-op work term report requirements, term unit load, course grades and credits, upgrading BSc, and repeating and counting course regulations and procedures.

Discussion included: clarification around the revisions to the repeating and counting course regulations; how the retroactivity for the reduced work term report requirement will work; the changes to the core average for honours co-operative medicinal chemistry – how it is calculated, how students are made aware of their standing and the fall-back if they do not achieve the average.
Following discussion there was a motion to (a) recommend that Senate approve the proposed addition of capstone courses to the Honour Biology, Environmental Biology Specialization (Reg. & Co-op) and Honours Environmental Science, Ecology Specialization (Reg. & Co-op), changes to the honours material and nanosciences plans, changes to co-operative education requirements, and changes to regulations and procedures, and (b) approve the remaining plan changes proposed by science on behalf of Senate. Spafford and Campbell. Carried.

4. **REGISTRAR’S OFFICE**

50% Rule. Members heard: this is part of the ongoing work to harmonize and centralize academic regulations and procedures, where possible; this rule is new for mathematics and engineering, but is already in place for the other faculties. There was a motion to recommend that Senate approve the regulation as presented. Newell Kelly and Ferries. Carried.

**Academic Calendar Dates and Guidelines.** Newell Kelly spoke to the proposed dates and guidelines, noting they have been approved at Senate Graduate and Research Council; the dates for the reading weeks include Thanksgiving and Family Day; the intention that the reading weeks encompass the weekends and holidays at the beginning and end of the breaks. Discussion included: deadlines for submitting grades following exams; messaging to be issued regarding the reading weeks; the possibility of adding another study day in the spring term; a correction to the last day of the co-op work term (December 23 not 24). Following discussion and subject to the correction re: the co-op work term date, there was a motion to recommend that Senate approve the academic calendar dates and guidelines as presented. Newell Kelly and MacVicar. Carried.

**Absence from Studies.** Newell Kelly updated members on the discussion at June Senate and request for clarifications, and indicated that the motion is being resubmitted to September Senate for decision.

5. **CO-OPERATIVE EDUCATION COUNCIL**

**PD Course.** Following presentation of the course by Fannon, there was a motion to approve the course on behalf of Senate. Wikkerink and Charbonneau. Carried.

6. **ACADEMIC PROGRAM REVIEWS**

**Academic Program Reviews – Status.** This item was received for information.

**Handling of Final Assessment Reports and Two Year Program Reviews.** This item was received for information.

[Spafford and Charbonneau withdrew for discussion and decision on the final assessment reports for Mathematical Studies and General and Honours Science.]

**FAR – Math/Business, Math/CPA, Math/FARM.** Reviewers indicated that they were pleased with the reports and responsiveness to suggested changes. Discussion included: progress on significant recommendations; how to respond to feedback from students interested in having more tailored course content. There was a motion to approve the report on behalf of Senate. Wolczuk and Vigna. Carried.

**FAR – Mathematical Studies.** The reviewers commented that the report is solid and the program was responsive to questions and recommended changes. There was a motion to approve the report on behalf of Senate. Wolczuk and Kolentsis. Carried.

**FAR – General and Honours Science.** Reviewers commented favourably on the report and responses to questions and recommendations. There was discussion around the finding that students in the program feel that the program is negatively perceived – the similarity to concerns in Mathematical Studies, whether this could be worded differently without undermining the importance of the concern, and options for responding to this feedback. There was a motion to approve the report on behalf of Senate. Larson and Wolczuk. Carried. McKenzie and Voigt will discuss wording around student perceptions with Spafford following the meeting.
2-Year Report – Statistics and Actuarial Science. Council’s reviewer noted: excellent progress has been made against significant recommendations; where the schedule has been amended, the changes are reasonable and credible. There was a motion to approve the report on behalf of Senate. Acheson and Campbell. Carried.

7. OTHER BUSINESS
There was no other business.

8. NEXT MEETING
The next meeting is scheduled for Tuesday 8 October 2019, 12:00 noon to 2:00 p.m. in NH 3318.

1 October 2019

Rebecca Wickens
Associate University Secretary
1. COURSE CHANGES [for approval]

1.1. Accounting and Financial Management – AFM

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1. COURSE CHANGES [for approval]

1.1. Accounting and Financial Management – AFM

Course: AFM 341

Change: Removal of AFM 241 as a prerequisite to AFM 341 (rescind approval for its addition at April 2019 UGAG and June 2019 SUC)

Rationale:

AFM 341 recently had a prerequisite course added to it (AFM 241) in a motion that was originally brought to the April 2019 UGAG meeting, and proceeded through the necessary approvals process thereafter. The rationale for the change was to ensure AFM students did not proceed with AFM 341 before having successfully completed AFM 241.

We have since learned that at least two related programs (Math/CPA and BioTech/CPA), while requiring AFM 341 as a degree requirement, do not require AFM 241 as a degree requirement. As a result, we are requesting to remove AFM 241 as a course prerequisite for AFM 341. Should AFM students opt to proceed as indicated above, we will address it on an individual advising basis.
The following items were approved by the Faculty of Engineering Undergraduate Studies Committee on June 28, 2019 and by Engineering Faculty Council on September 17, 2019. I am seeking approval for these items from Senate Undergraduate Council on October 8, 2019.

**Attachment #1** contains the modified portion of the calendar files for Complementary Studies Electives List (Item Ia), Options, Specializations and Electives for Engineering Students including all affected Options (Item Ib), Work Terms (Item Ic), Work Terms Study/Work Sequence (Item Id).

**Attachment #2** contains the modified portion of the calendar files along with the course catalog reports for Nanotechnology Engineering (Item II), Architectural, Civil, Environmental and Geological Engineering (Item III), Electrical and Computer Engineering (Item IV), Management Sciences Option (Item V), Mechatronics Engineering (Item VI), Biomedical Engineering (Item VII), and Systems Design Engineering (Item VIII).

[All changes are effective September 2020 unless otherwise noted.]

**NOTE:** ITEMS THAT DO NOT REQUIRE SENATE U/G COUNCIL APPROVAL ARE SHOWN AS SMALL CAPS IN ITALICS, WITH WAVE UNDERLINE. THESE ITEMS RECEIVE FINAL APPROVAL AT ENGINEERING FACULTY COUNCIL AND ARE FORWARDED TO SENATE U/G COUNCIL FOR INFORMATION AND IMPLEMENTATION.

**Items for Approval for the 2020-2021 calendar:**

1. **BASc and BSE Specific Degree Requirements**
   a. The following courses are added to the CSE List:
      - GEOG 207, Climate Change Fundamentals, to List A (Impact)
      - ARTS 490, Topic: Global Engagement Seminar, to List C
   b. Options, Specializations and Electives for Engineering Students
      - The introduction to this section of the calendar is updated to include current information.
      - The following options are revised: Life Sciences (replace CHEM 228 [inactivated] with CHEM 220); Physical Sciences (replace CHEM 217 [inactivated] with CHEM 212 or NE 225).
      - The following options are being inactivated: Mathematics Option (due to low enrolment); Water Resources Option (It will be replaced with a specialization); and the Computer Engineering Option (Currently offered to Systems Design Engineering students
• THE FOLLOWING OPTIONS HAVE MINOR CHANGES SUCH AS TITLE REVISIONS AND COURSE NUMBER CHANGES: ARTIFICIAL INTELLIGENCE, BIOMECHANICS, ENVIRONMENTAL ENGINEERING, MECHATRONICS AND STATISTICS. THESE ARE PRESENTED FOR INFORMATION.

<table>
<thead>
<tr>
<th>Option</th>
<th>Old</th>
<th>New</th>
</tr>
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<tbody>
<tr>
<td>Artificial Intelligence (Engineering) Option</td>
<td>MSCI 446 Data Warehouse and Mining</td>
<td>MSCI 446 Data Mining</td>
</tr>
<tr>
<td></td>
<td>SYDE 372 Introduction to Pattern Recognition</td>
<td>SYDE 572 Introduction to Pattern Recognition</td>
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<tr>
<td>Biomechanics Option</td>
<td>BIOL 301 Human Anatomy (F)</td>
<td>BIOL 201 Human Anatomy (F)</td>
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<td></td>
<td>SYDE 384 Biological and Human Systems (W)</td>
<td>SYDE 584 Biological and Human Systems (W)</td>
</tr>
<tr>
<td></td>
<td>SYDE 348 User Centred Design Methods (W)</td>
<td>SYDE 548 User Centred Design Methods (W)</td>
</tr>
<tr>
<td></td>
<td>SYDE 372 Introduction to Pattern Recognition (W)</td>
<td>SYDE 572 Introduction to Pattern Recognition (W)</td>
</tr>
<tr>
<td></td>
<td>SYDE 461 and SYDE 462 Systems Design Workshop 2 (F)/Systems Design Workshop 3 (W)</td>
<td>SYDE 461 and SYDE 462 Systems Design Capstone Project 1 (F)/Systems Design Capstone Project 2 (W)</td>
</tr>
<tr>
<td>Environmental Engineering Option</td>
<td>SYDE 332 Introduction to Complex Systems</td>
<td>SYDE 532 Introduction to Complex Systems</td>
</tr>
<tr>
<td>Mechatronics Option</td>
<td>GENE 123</td>
<td>GENE 123 or ME 123</td>
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<tr>
<td></td>
<td>SYDE 372</td>
<td>SYDE 572</td>
</tr>
<tr>
<td>Statistics Option</td>
<td>SYDE 372 Introduction to Pattern Recognition</td>
<td>SYDE 572 Introduction to Pattern Recognition</td>
</tr>
</tbody>
</table>

c. WORK TERMS AND PD COURSES: AFTER IN-DEPTH CONSULTATION WITH STUDENTS AND A YEARLONG REVIEW OF WATPD ENGINEERING, RECOMMENDATIONS WERE MADE WHICH INCLUDE A CHANGE TO THE PD CORE COURSES. THE FIRST PD COURSE WILL NOW BE A NEW COURSE, PD 19, TACTICS FOR WORKPLACE SUCCESS, AND THE SECOND WILL BE A REVISED VERSION OF THE CURRENT PD 20, STRATEGIES FOR CAREER SUCCESS. CALENDAR TEXT UNDER PROFESSIONAL DEVELOPMENT WAS REVISED TO REFLECT THE CHANGE FROM PD 21 TO PD 19.

II. Nanotechnology Engineering

The following changes are proposed:

a. Plan Changes
   • Change NE 352, Surfaces and Interfaces, from a technical elective to a 3B core course due to heavy demand. This reduces the number of 3B technical electives from three to two.
   • Antirequisite changes to NE 334 and NE 352, CHEM 450 to CHEM 400, due to inactivation of CHEM 450.
   • Revise the plan description to reflect the changes and remove non-contractual material not needed in the calendar.
   • Add Chemical Engineering as a prerequisite for NE 488 after “Level at least 3B Biomedical Engineering”.

b. Course Changes
- Revise the course description for NE 100, Introduction to Nanotechnology Engineering, as the topics now covered in other courses (NE 102, 109) are removed. Update prerequisites and antirequisites.
- Convert existing special topics courses into regular courses: NE 469 to 466 (Tactile Sensors and Transducers, 486 (Biosensors); 479 to 476 (Organic Electronics), 487 (Microfluidic and Nanobiotechnological Systems); 489 to 488 (Biomaterials and Biomedical Design) and 499 to 496 (Nanomaterials for Electrochemical Energy Systems). These courses have had regular enrolment and this will make them more available to other plans. Topics courses are still available under NE 453.
- Revise titles and descriptions for NE 454A/B and 455A/B/D Labs to refine the language and make clearer for student selection.

III. Architectural, Civil, Environmental and Geological Engineering

The following changes are proposed to the Architectural Engineering program:

a. Course Changes
- AE 123, Electrical Circuits and Instrumentation, replaces GENE 123 (same title) with two minor changes to the content (remove Thevenin and Norton models and time responses). No impact on teaching resources; ECE continues to teach this course.
- Add new seminar courses to 1B to 4B - AE 199, 298, 299, 398, 399, 498 and 499 to provide a Class Professor Hour to each of these terms. Timing is flexible to avoid conflicts with electives and course overrides will be approved if necessary.
- Add a new special topics course, AE 495, Design Intensive Special Topics in Architectural Engineering, which will be eligible for the Technical Elective List A.
- Add a new special topics course, AE 497, Special Topics in Architectural Engineering, with AE related content, to the Technical Elective List C.

b. New Specializations - a selection of upper year electives with a common theme provide the AE students an opportunity to specialize within their discipline. Two new specializations have been created:
- Building Structures Specialization
- Building Systems Specialization

Note: It is the intention to allow current students to choose these new specializations.

c. Modifications made to the AE Technical Elective Lists to align the TE lists with the specialization lists or to acknowledge the proposed AE and CIVE special topics courses.
- Add a new course, AE 495, Design Intensive Special Topics in AE, to List A.
- Modifications to List B: CIVE 495, Design Intensive Special Topics in CIVE, replaces CIVE 497; add CIVE 460, Engineering Biomechanics, and CIVE 596, Construction Engineering.
- Add a new course, AE 497, Special Topics in AE, to List C.

d. Minor editing to the plan introduction as well as editorial changes to Complementary Studies Electives, Technical Electives and Faculty Options to align with Civil Engineering calendar material where appropriate.

The following changes are proposed to the Civil Engineering program:

a. New Specializations - a selection of upper year electives with a common theme provide the CIVE students an opportunity to specialize within their discipline. Four new specializations have been created:
- Structural Specialization
- Transportation Specialization
- Geotechnical Specialization
- Water Resources Specialization

Note: It is the intention to allow current students to choose these new specializations.
specializations.

b. Course Changes
   • Replace GENE 123 with a new course, CIVE 123, Electrical Circuits and Instrumentation, to allow ownership of course and make minor changes to course content. No impact on teaching resources. ECE continues to teach this course.
   • Add a special topics course, CIVE 495, Design Intensive Special Topics in Civil Engineering, to meet the design intensive technical elective requirement in Civil and Environmental Engineering.
   • Change term of offering for CIVE 505, Structural Dynamics, from W to S to help improve the structural dynamics in applicable capstone design projects starting in 4A term.
   • Change secondary meet from LAB to TUT for CIVE 542, Structural Pavement Design, to align with current practice.

c. The host programs support the following modifications to Technical Electives lists A and B:
   • Add to List A – CIVE 495, Design Intensive Special Topics in Civil Engineering and EARTH 438, Engineering Geology.
   • Courses are added to List B which are included in specializations with support from the host departments: EARTH 444, Applied Wetland Science, EARTH 458, Physical Hydrogeology, GEG 209, Hydroclimatology, GEG 305, Fluvial Geomorphology, GEG 371, Advanced Remote Sensing Technology, GEG 381, Advanced Geographic Information Systems, ME 559, Finite Element Method, PLAN 416, Modelling the City and PLAN 477, Freight Planning and Policy.
   • Remove ARCH 277, Timber Design, Structure and Construction for Engineers, from the CIVE and GEOE programs as there are now qualified instructors within the CEE department who will develop and offer a design intensive special topics course in timber engineering.

d. Minor editing to the plan introduction as well as editorial changes to Complementary Studies Electives, Technical Electives and Faculty Options to align with all CEE programs.

The following changes are proposed to the Environmental Engineering program:

a. New Specializations - a selection of upper year electives with a common theme provide the ENVE students an opportunity to specialize within their discipline. Three new specializations have been created:
   • Hydrology Specialization
   • Pollution Treatment and Control Specialization
   • Energy Specialization

   Note: It is the intention to allow current students to choose these new specializations.

b. Course Changes
   • Replace GENE 123 with a new course, ENVE 123, Electrical Circuits and Instrumentation, to allow ownership of course and make minor changes to course content. No impact on teaching resources. ECE continues to teach this course.
   • Add a special topics course, ENVE 495, Design Intensive Special Topics in Environmental Engineering, to meet the design intensive technical elective requirement in Environmental Engineering.
   • Add as new course, ENVE 497, Special Topics in Environmental Engineering, specific to Environmental Engineering (previously used CIVE 497).

c. Modifications to Technical Elective Lists A and B
   • Add to List A: ENVE 495, Design Intensive Special Topics in Environmental Engineering, ENVE 497, Special Topics in Environmental Engineering, CHE 514, Fundamentals of Petroleum Production, ME 452, Energy Transfer in Buildings, SYDE 575, Image Processing and EARTH 438, Engineering Geology.
   • Add to List B: GEG 209, Hydroclimatology, GEG 305, Fluvial Geomorphology, GEG 371, Advanced Remote Sensing Technology and GEG 381, Advanced Geographic Information.
   • Move CIVE 440 from the ENVE technical elective List B as it will not be taught by a
• licensed instructor.

a. Minor editing to the plan introduction as well as editorial changes to Complementary Studies Electives, Technical Electives and Faculty Options to align with all CEE programs.

The following changes are proposed to the **Geological Engineering** program:

a. New Specializations - a selection of upper year electives with a common theme provide the GEOE students an opportunity to specialize within their discipline. Three new specializations have been created:
   - Geology Specialization
   - Hydrogeology Specialization
   - Soil, Rock and Structures Specialization
   **Note: It is the intention to allow current students to choose these new specializations.**

b. Course Changes
   - Replace GENE 123 with a new course, GEOE 123, Electrical Circuits and Instrumentation, to allow ownership of course and make minor changes to course content. No impact on teaching resources. ECE continues to teach this course.
   - Add a special topics course, GEOE 495, Design Intensive Special Topics in Environmental Engineering, to meet the design intensive technical elective requirement in Geological Engineering.
   - Add as new course, GEOE 497, Special Topics in Geological Engineering, specific to Geological Engineering (previously used CIVE 497).
   - Remove ARCH 277, Timber: Design, Structure and Construction for Engineers, from the 3A Technical Elective list as there is no interest in this course from the Geological Engineering students.
   - Change term of offering of CHE 514 in the Geological Engineering program listing from W to F to correct when it is actually offered.

c. Minor editing to the plan introduction as well as editorial changes to Complementary Studies Electives, Technical Electives and Faculty Options to align with calendar material in all CEE programs.

**IV. Electrical and Computer Engineering**

The following changes are proposed:

a. Separate the Electrical Engineering and Computer Engineering academic program listings in the undergraduate calendar to provide clear distinction and to be consistent with other departments that administer multiple programs.

b. For Electrical Engineering, inactivate ECE 209, Electronic and Electrical Properties of Materials, and replace it with a new course, ECE 231, Semiconductor Physics and Devices. By adding a new materials chemistry course in first year (ECE 109), this allowed for a redesign of ECE 209 and there is significant change to the course content to allow for a renumbering of the course.

c. Changes to the 1A term for both programs:
   - Remove ENGL 192/SPCOM 192 from the 1A term in both programs. The communications component is now covered in the concepts course, ECE 190, Engineering Profession and Practice, which is increased from 0.25 to 0.5 course weight.
   - Add a lab course, ECE 198, Project Studio, to the 1A term and remove the lab component of ECE 105, Classical Mechanics to keep the term in balance for both programs.

d. Changes to the 1B term for both programs:
• Remove the project from ECE 108, Discrete Mathematics and Logic I to reduce the workload in this term and ensure learning activities are aligned with the goals of the program.

e. Changes to the 2A term for both programs:
   • Add an optional lab to ECE 204, Numerical Methods, for those students who need it. Previous changes to this term will keep the workload in balance.

f. The first PD course will now be a new course, PD 19, Tactics for Workplace Success, and the second will be a revised version of the current PD20, Strategies for Career Success.

g. Changes to fourth year technical electives:
   • Move ECE 404 from 4B to 4A
   • Remove the antirequisite from ECE 409
   • Remove ECE 415 from the TE list due to low enrolment
   • Remove ECE 418 from the TE list as there is significant overlap with ECE 358
   • Remove the prerequisite (4A ECE) from ECE 464 and add MTE 320 or ME 269 as prerequisites
   • Update the course description for ECE 484 to clarify that the term of offering is Fall
   • Renumber the special topics course, ECE 493, to ECE 495, Autonomous Vehicles

V. **Management Sciences Option and Management Engineering**

The following are mainly of a housekeeping nature:

a) Changes to allowable replacements for MSCI 261 to reflect equivalent course additions and course inactivations: add AE 392, ENVE 392 and GEOE 392; remove ECE 390.

b) Remove BET 300 as an allowable replacement for MSCI 454 as it has been determined that they are not equivalent courses.

c) Course changes: update prerequisites for MSCI 422, 431, 432, 435, 452, 541 and 551; update the antirequisites for MSCI 211 and 251; update both the prerequisites and antirequisites for MSCI 261 and 454.

VI. **Mechatronics Engineering**

The following are housekeeping changes due to course changes submitted by Systems Design Engineering (no motion is required):

a. SYDE 348 renumbered to SYDE 548 - found in Mechatronics Engineering (4B TE)
b. SYDE 372 renumbered to SYDE 572 - found in AI Option (last list), Mechatronics Option (table 3), Mechatronics Engineering (4B TE)
c. SYDE 384 renumbered to SYDE 584 - found in Mechatronics Engineering (4B TE)

VI. **Biomedical Engineering**

The following changes are proposed:

a. Remove the explicit list of faculty options to avoid regular upkeep. These are updated regularly elsewhere in the calendar.

b. Renumber BME 450, Sports Engineering to BME 550 and BME 451, Biomechanics of Human
Movement, to BME 551 to make these courses available to MASc and MEng students.

VII. Systems Design Engineering

The following changes are proposed:

a. Remove the list of specific faculty options to avoid regular upkeep. Replace it with a generic reference that links to the list of options elsewhere in the calendar. Remove the Computer Engineering Option description since a replacement is being explored.

b. Update the prerequisites for SYDE 542 to facilitate course selection enrollment for Management Engineering students.

c. Update course titles and descriptions for: SYDE 361, 362, 461 and 462 to reflect recent updates to the SYDE curriculum.

d. Update the course description and remove the antirequisite of SYDE 261 to reflect recent updates to the SYDE curriculum.

e. Renumber SYDE 300-level technical electives to SYDE 500-level courses to allow a subset of Masters level students from more traditional engineering programs to take them. Prerequisites will remain to allow 3A BME and 3B SYDE and above to enroll. The courses include: SYDE 332 to become SYDE 532, SYDE 348 to become SYDE 548, SYDE 372 to become SYDE 572 and SYDE 384 to become SYDE 584. All course titles will remain the same.

Paul Fieguth
Acting Associate Dean of Engineering
Undergraduate Studies

SUC submission October 8, 2019
## Complementary Studies Requirements for Engineering Students

### List A – Impact Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>BET 420</td>
<td>Entrepreneurship for Social Impact</td>
</tr>
<tr>
<td>BME 381</td>
<td>Biomedical Engineering Ethics</td>
</tr>
<tr>
<td>ECE 390</td>
<td>Engineering Design, Economics, and Impact on Society</td>
</tr>
<tr>
<td>ENVS 105</td>
<td>Environmental Sustainability and Ethics</td>
</tr>
<tr>
<td>ENVS 205</td>
<td>Sustainability: The Future We Want</td>
</tr>
<tr>
<td>ERS 215</td>
<td>Environmental and Sustainability Assessment I</td>
</tr>
<tr>
<td>ERS 315</td>
<td>Environmental and Sustainability Assessment II</td>
</tr>
<tr>
<td>GENE 22A</td>
<td>Topics for List A Complementary Studies Courses Taken on Exchange by Engineering Students</td>
</tr>
<tr>
<td>GEOG 203</td>
<td>Environment and Development in a Global Perspective</td>
</tr>
<tr>
<td>GEOG 207</td>
<td>Climate Change Fundamentals</td>
</tr>
<tr>
<td>GEOG 368</td>
<td>Conservation/Resource Management of the Built Environment</td>
</tr>
<tr>
<td>GSJ 205</td>
<td>Technology, Gender, and Social Justice</td>
</tr>
<tr>
<td>MSC1 422</td>
<td>Economic Impact of Technological Change and Entrepreneurship</td>
</tr>
<tr>
<td>MSC1 442</td>
<td>Impact of Information Systems on Organizations and Society</td>
</tr>
<tr>
<td>NE 109</td>
<td>Societal and Environmental Impacts of Nanotechnology</td>
</tr>
<tr>
<td>PHIL 226</td>
<td>Biomedical Ethics</td>
</tr>
<tr>
<td>SOC 232</td>
<td>Technology and Social Change</td>
</tr>
<tr>
<td>STV 100</td>
<td>Society, Technology and Values: Introduction</td>
</tr>
<tr>
<td>STV 202</td>
<td>Design and Society</td>
</tr>
<tr>
<td>STV 205</td>
<td>Cybernetics and Society</td>
</tr>
<tr>
<td>STV 210</td>
<td>The Computing Society</td>
</tr>
<tr>
<td>STV 302</td>
<td>Information Technology and Society</td>
</tr>
<tr>
<td>STV 304</td>
<td>Technology in Canadian Society</td>
</tr>
<tr>
<td>STV 305</td>
<td>Technology, Society and the Modern City</td>
</tr>
<tr>
<td>STV 306</td>
<td>Biotechnology and Society</td>
</tr>
<tr>
<td>SYDE 261</td>
<td>Design, Systems, and Society</td>
</tr>
</tbody>
</table>
Other courses may be acceptable for this requirement. Prior approval is required from your department associate chair.

List B – Engineering Economics Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE 392</td>
<td>Economics and Life Cycle Analysis</td>
</tr>
<tr>
<td>BME 364</td>
<td>Engineering Biomedical Economics</td>
</tr>
<tr>
<td>CIVE 392</td>
<td>Economics and Life Cycle Cost Analysis</td>
</tr>
<tr>
<td>ECE 390</td>
<td>Engineering Design, Economics, and Impact on Society</td>
</tr>
<tr>
<td>GENE 22B</td>
<td>Topics for List B Complementary Studies Courses Taken on Exchange by Engineering Students</td>
</tr>
<tr>
<td>MSCI 261</td>
<td>Engineering Economics: Financial Management for Engineers</td>
</tr>
<tr>
<td>SYDE 262</td>
<td>Engineering Economics of Design</td>
</tr>
</tbody>
</table>

List C – Humanities and Social Sciences Courses

Course scheduling is an evolving process at the University 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 (ANTH): All
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
Classical Studies (CLAS): All
East Asian Studies: EASIA 100R
Economics: All except ECON 211, ECON 221, ECON 311, ECON 371, ECON 412, ECON 421, ECON 422, ECON 471
English: All except ENGL 109, ENGL 119, ENGL 129R, ENGL 140R, ENGL 210E, ENGL 210F
Environmental Studies: ENVS 195, ENVS 205
Fine Arts (FINE): * see home department associate chair
French Studies: FR 296, FR 297
Gender and Social Justice: All except GSJ 371 (may be acceptable at the discretion of the associate chair when a course outline is shown)
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 your departmental regulations.

Accounting and Financial Management: AFM 131
Architectural Engineering: AE 491
Business Entrepreneurship and Technology: BET 410A and BET 410B
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
Environmental Engineering: ENVE 391
Environmental Studies: ENVS 201, ENVS 401
Fine Arts (FINE): * see home department associate chair
General Engineering (Topics): GENE 22D (Taken on exchange by Engineering students)
General Engineering: GENE 315, GENE 415
Management Sciences: MSCI 421, MSCI 454
Mechanical Engineering: ME 401
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: REC 100
Religious Studies: RS 131, RS 132
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 enrol early are most likely to get their choice. Attempts to enrol 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 prefix of the department, 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. Please 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 Engineering undergraduate degrees, Bachelor of Applied Science (BASc) and Bachelor of Software Engineering (BSE), consist of two course groupings:
   - Compulsory core courses within the plan and which prepares the student for practice in that particular branch of engineering and comprises 70% to 80% of the course load.
   - Elective courses, which comprise 20% to 30% of the course load. Of these elective courses:
     - **Complementary Studies Electives**: A minimum of five Complementary Studies elective courses must be chosen from subjects that complement and provide breadth to the engineering curriculum. This Complementary Studies requirement gives students some breadth of studies related to their role as educated professionals in society. (See Complementary Studies Requirement section and plan section for more information. See each plan section of this Calendar for the specific number of complementary courses for each plan.)
     - **Technical Electives**: Technical elective courses are 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.) In the elective courses, students with special interests may, with the approval of their department associate chair (or academic advisor) structure individual elective course groupings. However, for reasons of academic continuity and scheduling, particular course groupings have been identified and are recommended to students. Some of these course groupings are pre-scheduled to ensure that courses in the group will not conflict with core courses.

2. The remaining elective courses are usually chosen from engineering department courses which will give some depth in a particular technical discipline appropriate to a student's branch of engineering. (See Engineering plan descriptions later in this section of this Calendar for listings of suggested elective course groupings of this type.)

3. The Faculty of Engineering recognizes both designated options and designated specializations within the BASc and BSE degrees. For students that meet a designated option or a designated specialization requirement, the credential is recognized on both the diploma and the transcript. Options are intended to recognize a field of study outside of the basic degree while specializations are intended to recognize success in a concentration within the electives available within the degree specification. Descriptions of the options are provided in BASc and BSE Specific Degree Requirements and descriptions of 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 encouraged to use a Plan Modification Form and are required to declare an option or specialization for it to be recognized as part of their degree and to appear on the diploma.

4. For a designation (option or specialization) to appear on the transcript, a student must achieve an average of at least 60% in the option or specialization courses and at least 50% in each course.

5. Any given course can only be counted for two credentials. For example; the basic degree and one option, or the basic degree and one specialization, or one option and one specialization.

6. Designated Options. Certain elective course groupings have been recognized by the Faculty of Engineering or the University as Designated Options. Students who complete the requirements of
these options will have a designation of completion of the option recorded on their transcripts. Detailed descriptions of these current options are provided in BASc and BSE Specific Degree Requirements. The options and option co-ordinators are listed on the designated options and co-ordinators web page. The option co-ordinator can provide advice and assist in the organization and selection of courses for the option.

Students are encouraged to use a Plan Modification Form to declare a specialization or option. Students are required to declare an option or specialization for it to be recognized as part of their degree and to appear on the diploma.

7. Because Designated Options can require up to eight courses, it may be necessary for students to take extra courses to complete the required work in some options. To carry 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. Details follow later in this section. BSE students should refer to the section on Software Engineering, for options that are open to them.

8. Designated specializations are described within the specific plan description in this Calendar.

9. Although Engineering does not offer minors to students enrolled in Engineering, many departments of other faculties do. A minor normally requires a minimum of eight or 10 courses chosen from lists prepared by the department offering the minor. Engineering students who choose a minor must take extra courses chosen from lists prepared by the department offering the minor. Often courses in a minor can also may be used to satisfy some of the requirements of the technical electives or complementary studies electives course groups.

10. In addition, students may take advantage of other opportunities including the Interdisciplinary Alternatives for Engineering Students, the Accelerated Master's Program, and it is possible for a graduate with a BASc degree in Engineering to complete the requirements for a concurrent Bachelor of Arts (BA) degree. This process, A concurrent BA degree, will require a significant number of extra courses as well as agreement by both the Faculties of Arts and the Faculty of Engineering. Interested students should start by consulting with their undergraduate advisor.

Notes:

1. Options, specializations, and electives available to Engineering students are subject to change and development. Students are advised to obtain the latest information from their department undergraduate office or the Faculty of Engineering Associate Dean's Office before making final decisions.

2. For course content, see course descriptions under the prefix of department, board or faculty offering the course (e.g., CIVE—Civil Engineering, PHIL—Philosophy, GENE—General Engineering, etc.).
## Computer Engineering Option

This is a Designated Faculty Option which is available to students in Systems Design Engineering to give greater training in software and to augment digital hardware capabilities. For details, see the Systems Design Engineering section of this Calendar.

## Life Sciences Option

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

### Notes

1. Each of the two options has a number of themes; the requirements for each theme are listed in the corresponding table for the option.
2. 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.
3. Some students in the option(s) may wish to further specialize within a given theme.
4. 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.
5. 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.

The aim of the Life Sciences Option is to provide a Bachelor of Applied Science (BASc) and Bachelor of Software Engineering (BSE) student with an understanding of the structure and function of biological systems that is both broader and deeper than can normally be attained within the context of any one engineering academic plan. 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 or 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

- [List of courses]

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Electives: choose three

**Theme 3: Biophysical Science**

**Required Courses**

- CHEM 123 or CHE 102 or NE 121, PHYS 125 or ECE 105, PHYS 280/BIOL 280, PHYS 380

Electives: choose three

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

**Theme 4: Biochemical Science**

**Required Courses**

- CHE 161, CHEM 123 or CHE 102 or NE 121, CHEM 266 or CHEM 262 or NE 222, CHEM 267

Electives: choose three

- CHEM 228 220, CHEM 237 or CHEM 233 or NE 224, CHEM 333, CHEM 357, CHEM 430, CHEM 432

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

**Mathematics Option**

The Mathematics Option is to be inactivated.

The aim of the Mathematics Option is to provide the student with a broad background in either pure or applied mathematics with an opportunity to take some courses in an area of specialization.

There are six required courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 211</td>
<td>Advanced Calculus 1 for Electrical and Computer Engineers (or equivalent)</td>
</tr>
<tr>
<td>MATH 212</td>
<td>Advanced Calculus 2 for Electrical Engineers (or equivalent)</td>
</tr>
<tr>
<td>ECE 316</td>
<td>Probability Theory and Statistics (or equivalent)</td>
</tr>
<tr>
<td>MATH 235</td>
<td>Linear Algebra 2 for Honours Mathematics</td>
</tr>
<tr>
<td>either</td>
<td></td>
</tr>
<tr>
<td>PMATH 334</td>
<td>Introduction to Rings and Fields with Applications</td>
</tr>
<tr>
<td>or PMATH 336</td>
<td></td>
</tr>
<tr>
<td>either</td>
<td></td>
</tr>
<tr>
<td>AMATH 331/PMATH 331</td>
<td>Applied Real Analysis</td>
</tr>
<tr>
<td>or AMATH 332/PMATH 332</td>
<td>Applied Complex Analysis</td>
</tr>
</tbody>
</table>

A student must also take two courses from the following, subject to availability and timetable constraints.
<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMATH 331/PMATH 331</td>
<td>Applied Real Analysis</td>
</tr>
<tr>
<td>AMATH 332/PMATH 332</td>
<td>Applied Complex Analysis</td>
</tr>
<tr>
<td>AMATH 351</td>
<td>Ordinary Differential Equations 2</td>
</tr>
<tr>
<td>AMATH 353</td>
<td>Partial Differential Equations 1</td>
</tr>
<tr>
<td>AMATH 361</td>
<td>Continuum Mechanics</td>
</tr>
<tr>
<td>AMATH 451</td>
<td>Introduction to Dynamical Systems</td>
</tr>
<tr>
<td>AMATH 453</td>
<td>Partial Differential Equations 2</td>
</tr>
<tr>
<td>AMATH 456</td>
<td>Calculus of Variations</td>
</tr>
<tr>
<td>CO 250</td>
<td>Introduction to Optimization</td>
</tr>
<tr>
<td>CO 342</td>
<td>Introduction to Graph Theory</td>
</tr>
<tr>
<td>CO 367</td>
<td>Nonlinear Optimization</td>
</tr>
<tr>
<td>MATH 239</td>
<td>Introduction to Combinatorics</td>
</tr>
<tr>
<td>PMATH 334</td>
<td>Introduction to Rings and Fields with Applications</td>
</tr>
<tr>
<td>PMATH 336</td>
<td>Introduction to Group Theory with Applications</td>
</tr>
<tr>
<td>PMATH 340</td>
<td>Elementary Number Theory</td>
</tr>
<tr>
<td>PMATH 360</td>
<td>Geometry</td>
</tr>
<tr>
<td>PMATH 365</td>
<td>Differential Geometry</td>
</tr>
</tbody>
</table>

The list of courses will be subject to change from time to time. For further information contact the option coordinator.

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**Physical Sciences Option**

The Faculty of Science provides access to two options for Engineering students; the [Life Sciences Option](#) and the Physical Sciences Option.

**Notes**

1. Each of the two options has a number of themes; the requirements for each theme are listed in the corresponding table for the option.
2. 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.
3. Some students in the option(s) 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.
4. 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.
5. 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.
6. Due to the overlap with the regular plan, the Earth and Environmental Sciences theme is not available to Geological Engineering students.

The aim of the Physical Sciences Option is to provide a Bachelor of Applied Science (BASc) and Bachelor of Software Engineering (BSE) student with an understanding of the basic physical sciences that lie behind many engineering applications that is both broader and deeper than can normally be attained within the context of any one Engineering academic plan. The Physical Sciences Option has three theme areas, namely, 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

PHYS 115 or PHYS 121 or ECE 105 or NE 131, PHYS 122 or PHYS 125 or ECE 106 or NE 241 or SYDE 283, PHYS 234 or NE 332

Plus one of:

ECE 140 or PHYS 242 or PHYS 263 or PHYS 334 or 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

CHEM 123 or CHE 102 or NE 121, CHEM 209, CHEM 217, 212 or NE 225, CHEM 266

Electives: choose three

CHEM 220, CHEM 221, CHEM 254 or CHE 230 or ECE 309 or ME 250 or SYDE 381, CHEM 265, CHEM 310, CHEM 313, CHEM 323, CHEM 340, CHEM 350, CHEM 356 or NE 332 or 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

CHEM 264, CHEM 265, CHEM 360

Physical Chemistry

CHEM 254, CHEM 350, CHEM 356

Theme 3: Earth and Environmental Sciences

Required Courses

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

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
Water Resources Option

This Option is for students interested in the development, management, and protection of water resources. Students are prepared for careers with consulting firms or regulatory agencies. They acquire the background to design and evaluate hydraulic structures, pollution control schemes, and water management systems. They are also exposed to the social and environmental aspects of use of water resources. A minimum of seven courses is required; however, most students in Civil Engineering will probably wish to take more.

Legend

F—fall term, W—winter term, S—spring term

Required Courses

There are four required courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 280 (S)</td>
<td>Fluid Mechanics (or equivalent)</td>
</tr>
<tr>
<td>CIVE 375 (F)</td>
<td>Environmental Engineering Principles</td>
</tr>
<tr>
<td>CIVE 382 (F,W)</td>
<td>Hydrology and Open Channel Flow</td>
</tr>
<tr>
<td>ENVE 383 (W)</td>
<td>Advanced Hydrology and Hydraulics</td>
</tr>
</tbody>
</table>

Elective Courses

A minimum of three elective courses is required to be taken from the following list, subject to timetable constraints:

Surface Water

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 583 (W)</td>
<td>Design of Urban Water Systems</td>
</tr>
<tr>
<td>ENVE 573 (W)</td>
<td>Contaminant Transport</td>
</tr>
</tbody>
</table>

Treatment

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 361 (F,W)</td>
<td>Bioprocess Engineering</td>
</tr>
<tr>
<td>CHE 574 (W)</td>
<td>Industrial Wastewater Pollution Control</td>
</tr>
</tbody>
</table>

Groundwater

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTH 458 (F,S)</td>
<td>Physical Hydrogeology</td>
</tr>
<tr>
<td>EARTH 459 (W)</td>
<td>Chemical Hydrogeology</td>
</tr>
</tbody>
</table>

Management

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENVE 335 (W)</td>
<td>Decision Making for Environmental Engineers</td>
</tr>
<tr>
<td>ENVE 577 (W)</td>
<td>Engineering for Solid Waste Management</td>
</tr>
<tr>
<td>SYDE 533 (F)</td>
<td>Conflict Resolution</td>
</tr>
</tbody>
</table>
Mathematics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title and Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 559 (F,S)</td>
<td>Finite-Element Methods</td>
</tr>
<tr>
<td>SYDE 311 (S)</td>
<td>Advanced Engineering Math 2 (not available to Civil Engineering students)</td>
</tr>
<tr>
<td>SYDE 312 (W)</td>
<td>Applied Linear Algebra</td>
</tr>
<tr>
<td>SYDE 531 (W)</td>
<td>Design Optimization Under Probabilistic Uncertainty</td>
</tr>
</tbody>
</table>

Remote Sensing

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOG 371</td>
<td>Advanced Remote Sensing Techniques</td>
</tr>
<tr>
<td>GEOG 471 (W)</td>
<td>Remote Sensing Project</td>
</tr>
</tbody>
</table>

Air Pollution

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 572 (W)</td>
<td>Air Pollution Control</td>
</tr>
<tr>
<td>ME 571 (W)</td>
<td>Air Pollution</td>
</tr>
</tbody>
</table>

Fluids

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 362 (F,W)</td>
<td>Fluid Mechanics 2</td>
</tr>
<tr>
<td>ME 566 (F,S)</td>
<td>Computational Fluid Dynamics for Engineering Design</td>
</tr>
</tbody>
</table>

Other courses may be substituted with permission of the associate chair for undergraduate studies and the option coordinator. Course offerings are subject to change; check with the appropriate department to ensure course availability.

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 labelled as 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 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** and **PD 21** (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 advisor.

**Quantity**

Upon entry to Engineering (including advanced admission), a student is expected to follow the work-term/academic-term sequence which corresponds to their specific plan. The minimum number of 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 System section of the 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.

**Work Terms – Study/Work Sequence**

**Legend – BASc and BSE**

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
</table>
| S/S | Sequence/Stream  
*Engineering plans:* 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, 4S=special sequencing of terms; 8X=one extended work term |
| F,W,S | Terms: F=September-December; W=January-April; S=May-August |
| 1,2,3,4,5 plus A or B | Denotes academic year and term. |
### Key

<table>
<thead>
<tr>
<th>Key</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WT</td>
<td>Minimum number of credited work terms required for graduation (four credited work reports are also required for graduation for all co-op students; an employer evaluation is required for each work term students undertake).</td>
</tr>
<tr>
<td>WR</td>
<td>Denotes the minimum number of work-report (WR) credits required for the co-op designation.</td>
</tr>
<tr>
<td>PD</td>
<td>Denotes the minimum number of professional development (PD) credits required for the co-op designation.</td>
</tr>
<tr>
<td>•</td>
<td>Denotes number of scheduled work terms per sequence.</td>
</tr>
<tr>
<td>off</td>
<td>Denotes a term in which students are not registered at the University of Waterloo for classes and are not on a co-op work term.</td>
</tr>
<tr>
<td>Ф</td>
<td>Three work-report credits (in addition to PD 20 and 21).</td>
</tr>
<tr>
<td>1</td>
<td>Although co-op begins in 2A, admission is made at the time of the initial application to the University.</td>
</tr>
<tr>
<td>21</td>
<td>The streaming for Electrical and Computer Engineering varies depending on demand.</td>
</tr>
<tr>
<td>¬</td>
<td>Not applicable.</td>
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### Study/Work Sequence Information

<table>
<thead>
<tr>
<th>Plan</th>
<th>≈</th>
<th>S/ S</th>
<th>F</th>
<th>W</th>
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<th>F</th>
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<th>F</th>
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<th>S</th>
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<td>3B</td>
<td>4A</td>
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<td>4B</td>
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<td>Architecture¹</td>
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<td>4A</td>
<td>1B</td>
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<td>•</td>
<td>2B</td>
<td>•</td>
<td>3A</td>
<td>•</td>
<td>3B</td>
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<td>4A</td>
<td>•</td>
<td>4B</td>
<td>¬</td>
<td>5</td>
</tr>
<tr>
<td>Biomedical, Mechatronics</td>
<td>8X</td>
<td>1A</td>
<td>1B</td>
<td>•</td>
<td>2A</td>
<td>•</td>
<td>2B</td>
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<td>•</td>
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<td>4B</td>
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<td>1B</td>
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<td>1B</td>
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<td>4B</td>
<td>¬</td>
<td>5</td>
<td>Ф</td>
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<tr>
<td>Environmental</td>
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<td>1A</td>
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<td>2A</td>
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<td>3A</td>
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</table>

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Co-operative System of Study

The Honours Bachelor of Architectural Studies, 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 Honours 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 temporary 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.

The terms are arranged as indicated in Study/Work Sequence for Architecture.

Legend - BAS

<table>
<thead>
<tr>
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<th>Description</th>
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<td>F,W,S</td>
<td>Terms: F=September-December; W=January-April; S=May-August</td>
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<td>1,2,3,4 plus A or B</td>
<td>Denotes academic year and term.</td>
</tr>
<tr>
<td>•</td>
<td>Denotes number of scheduled work terms per sequence.</td>
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<tr>
<td>off</td>
<td>Denotes a term in which students are not registered at the University of Waterloo for classes and are not on a co-op work term.</td>
</tr>
<tr>
<td>1</td>
<td>Although co-op begins in 2A, admission is made at the time of the initial application to the University.</td>
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### Study/Work Sequence Information

<table>
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<th>Program</th>
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<td></td>
<td></td>
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<td>4A</td>
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Nanotechnology Engineering

Nanotechnology engineering is a multi-disciplinary engineering field that simultaneously draws from and benefits areas such as materials science and engineering, chemistry, physics, and biology. Indeed, it is all about generating new solutions based upon atomic- and molecular-scale concepts and manipulations.

Nanotechnology commonly refers to the fabrication, study, and manipulation of structures having sizes in the range from one to one hundred nanometers (a nanometer is a billionth of a metre). This length scale bridges the important gap between atoms and molecules (which are typically less than five nanometers in size) and bulk materials, thereby requiring a knowledge of fundamental chemistry and quantum physics. To develop this new cluster of technologies, there is an acute need for highly trained personnel who have a thorough understanding of the natural laws that govern the workings not only of atoms and molecules but also of natural or manufactured nanoscopic and mesoscopic structures and systems (such as, clusters, fullerenes, nanotubes, macromolecules, nanorobots, and nanosystems more generally).

This field is loosely divided into four categories, namely: micro and nano-instrumentation, nanoelectronics, nanobiosystems, and nano-engineered materials. The first category addresses some of the most far-reaching, yet practical, applications of miniaturized instrumentation for the study of molecular-scale species in chemical, clinical, or biochemical analysis, in biotechnology for agent detection, and in environmental analysis. The second category concerns the development of systems and materials required for the electronics industry in order to move beyond current technological limits – producing even finer detail than currently featured in high-performance microprocessor chips. Also, in this category is a new generation of electronic devices based upon organic and plastic materials, which is expected to create new markets with applications ranging from smart cards to tube-like computers. The third category can be described as molecular manipulation of biomaterials and the associated miniaturization of analytical devices in terms of DNA, peptides, proteins, and cell chips. The final category examines several classes of advanced materials, including nanocrystalline materials and nanopowders, that can be utilized in electronics and photonics applications, in the automobile, food, and pharmaceutical industries, as membranes for fuel cells, and as industrial-scale polymers.

The Nanotechnology Engineering honours degree plan is designed to provide an education in key areas of nanotechnology, including the fundamental chemistry, physics, and engineering of nanostructures or nanosystems and the theories and techniques employed in the modelling, design, fabrication, and characterization of technological applications. Emphasis is placed on training with the same modern instrumentation techniques employed in research and development in these emerging technologies. The University awards a Bachelor of Applied Science (BASc) degree in Nanotechnology Engineering to students who successfully meet all plan requirements.

This engineering plan is a collaborative effort among three departments: the Department of Chemical Engineering and the Department of Electrical and Computer Engineering in the Faculty of Engineering, and the Department of Chemistry in the Faculty of Science.
Administrative Structure

Leadership for the Nanotechnology Engineering plan is provided by the Nanotechnology Engineering director, normally a faculty member chosen from one of the Departments of Chemical Engineering, Chemistry, or Electrical and Computer Engineering, and holding a joint or cross appointment in the other departments. The director is responsible for academic issues associated with the plan operation, including student liaison and advisement. Two associate directors assist the director in managing the day-to-day operations and in student advisement.

The Nanotechnology Engineering Board oversees the operation and evolution. This inter-faculty board normally meets once a year. It consults with the three home departments and reports to the two faculty councils. Board membership comprises the following.

- Nanotechnology Engineering Director, Chair of committee
- Dean, Faculty of Engineering
- Dean, Faculty of Science
- Chair, Department of Chemical Engineering
- Chair, Department of Chemistry
- Chair, Department of Electrical and Computer Engineering
- Undergraduate Associate Chair, Department of Chemical Engineering
- Undergraduate Officer, Department of Chemistry
- Undergraduate Associate Chair, Department of Electrical and Computer Engineering

The Board delegates issues of plan operation to the Nanotechnology Engineering Executive Committee and issues of curriculum to the Nanotechnology Engineering Curriculum Committee.

The Nanotechnology Engineering Executive Committee monitors the operation of Nanotechnology Engineering. It normally meets monthly and coordinates requests for instructors, teaching assistants, or resources for courses and laboratories. It reports to the Nanotechnology Engineering Board. Its membership comprises the following.

- Nanotechnology Engineering Director, Chair of committee
- Chair, Department of Chemical Engineering
- Chair, Department of Chemistry
- Chair, Department of Electrical and Computer Engineering
- Nanotechnology Engineering Associate Director, Internal
- Nanotechnology Engineering Associate Director, External

The Nanotechnology Engineering Curriculum Committee is responsible for curriculum issues of the Nanotechnology Engineering plan and reports to the Nanotechnology Engineering Board. Its membership comprises the following.

- Nanotechnology Engineering Associate Director, Internal, Chair of committee
- Nanotechnology Engineering Director
- Nanotechnology Engineering Associate Director, External
- Undergraduate Associate Chair, Department of Chemical Engineering
The three teaching faculty members are appointed by their respective department chairs.

At the faculty level, academic responsibility for Nanotechnology Engineering rests with the Faculty of Engineering and is handled via its normal procedures and committees.

Admissions

Nanotechnology Engineering Committee, in consultation with the Faculties of Engineering and Science, and their admissions committees, recommends admission requirements for the Nanotechnology Engineering plan to the Faculty of Engineering. For details on admission in this plan, see the Academic Course Requirements.

Academic Curriculum

The curriculum in Nanotechnology Engineering is designed to teach those fundamental physical and engineering sciences that form the basis of the work of nanotechnology engineers. The curriculum in Nanotechnology Engineering consists of a set of core courses complemented by nine technical elective courses plus three non-technical elective courses that include a communication elective, in addition to NE 109 and MSCI 261 in order to satisfy the Complementary Studies Requirements for Engineering Students.

Technical Electives

Generally speaking, 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 nine technical elective course choices is provided in the curriculum to enable students to focus upon at least two of these areas of concentration. The technical elective courses may be chosen from amongst approximately 15 Nanotechnology-Engineering-specific technical elective courses that are normally offered annually. In addition, students may obtain permission from the Nanotechnology Engineering academic advisor (normally the associate director, internal) to employ up to four courses (one each in the 3B and 4A terms, two in the 4B term), appropriate to their choices of areas of concentration, that are offered under other Faculty of Engineering academic plans.

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 internal, 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 two four-month work terms following the 1B and 2A terms, and two eight-month work terms following the 2B and 3B terms. The rules of the Co-operative Education System 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.

Available Options

Students wishing to enrich their education further may elect to follow a Faculty of Engineering Designated Option. Students who complete the requirements for an option will have a designation of completion of that option recorded on their transcripts. Students should be aware that an option normally requires additional courses to be completed. An 80% average is required to enter the Life Sciences Option, Mathematics Option, or Physical Sciences Option. Faculty Options of special interest to Nanotechnology Engineering students are described in the Options, Specializations and Electives for Engineering Students of this section of the Calendar, under the following headings.

- Artificial Intelligence (Engineering) Option
- International Studies in Engineering Option
- Life Sciences Option
- Management Sciences Option
- Mathematics Option
- Physical Sciences Option

Academic Curriculum

Legend for the next table

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cls</td>
<td>Class</td>
</tr>
<tr>
<td>Tut</td>
<td>Tutorial</td>
</tr>
<tr>
<td>Lab</td>
<td>Laboratory</td>
</tr>
<tr>
<td>0-10</td>
<td>Number of hours per week for Class, Tutorial, or Laboratory</td>
</tr>
<tr>
<td>†</td>
<td>More than one course may be offered simultaneously under a given special topic this course number.</td>
</tr>
<tr>
<td>‡</td>
<td>NE 102, NE 201, NE 202, and NE 301 provide milestones that must be passed before a student may proceed in the academic plan. Successful completion is required by the end of the academic term following that having the scheduled meets. Specifically, a student will not be allowed to enrol in any academic term beyond 2A without credit for NE 102, beyond 2B without credit for NE 201, beyond 3A without credit for NE 202, beyond 3B without credit for NE 301.</td>
</tr>
<tr>
<td>**</td>
<td>The Communication Elective represents a milestone that must be completed prior to</td>
</tr>
</tbody>
</table>
enrolling in the 3A term. The milestone can be completed by passing one course from the following list: ENGL 109, ENGL 129R/EMLS 129R, EMLS 101R, EMLS 102R, SPCOM 100, SPCOM 223. The course cannot be taken online.

For some of these courses the number of contact hours for the tutorial or laboratory are unknown; there may be more components than the class (Cls) section.

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

<table>
<thead>
<tr>
<th>Term</th>
<th>Course and Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A Fall</td>
<td>MATH 117 Calculus 1 for Engineering</td>
<td>3</td>
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<tr>
<td></td>
<td>NE 100 Introduction to Nanotechnology Engineering</td>
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<tr>
<td></td>
<td>NE 101 Nanotechnology Engineering Practice</td>
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<td></td>
<td>NE 109 Societal and Environmental Impacts of Nanotechnology</td>
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<tr>
<td></td>
<td>NE 111 Introduction to Programming for Engineers</td>
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<tr>
<td></td>
<td>NE 112 Linear Algebra for Nanotechnology Engineering</td>
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<td></td>
<td>NE 121 Chemical Principles</td>
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<td>MATH 119 Calculus 2 for Engineering</td>
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<td>NE 102 Introduction to Nanomaterials Health Risk; Nanotechnology Engineering Practice ‡</td>
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<td>NE 113 Introduction to Computational Methods</td>
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<td>NE 125 Introduction to Materials Science and Engineering</td>
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<td>NE 131 Physics for Nanotechnology Engineering</td>
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<td>NE 140 Linear Circuits</td>
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<td>2A Fall</td>
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<td>NE 216 Advanced Calculus and Numerical Methods 1</td>
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<td>NE 226 Characterization of Materials</td>
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**3A Spring**

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<td>MSCI 261</td>
<td>Engineering Economics: Financial Management for Engineers</td>
<td>3</td>
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<td>NE 301</td>
<td>Nanomaterials and Human Risks, Benefits; Nanotechnology Engineering Practice</td>
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<td>NE 318</td>
<td>Continuum Mechanics for Nanotechnology Engineering</td>
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<td>NE 320L</td>
<td>Characterization of Materials Laboratory</td>
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<td>NE 332</td>
<td>Quantum Mechanics</td>
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<tr>
<td>NE 333</td>
<td>Macromolecular Science</td>
<td>3</td>
<td>1</td>
<td>0</td>
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<tr>
<td>NE 343</td>
<td>Microfabrication and Thin-film Technology</td>
<td>3</td>
<td>1</td>
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</table>

**3B Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Hours</th>
<th>Remarks</th>
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</thead>
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<tr>
<td>NE 302</td>
<td>Nanotechnology Engineering Practice</td>
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<tr>
<td>NE 307</td>
<td>Introduction to Nanosystems Design</td>
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<td>NE 330L</td>
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<td>NE 334</td>
<td>Statistical Thermodynamics</td>
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<td>1</td>
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<tr>
<td>NE 336</td>
<td>Micro and Nanosystem Computer-aided Design</td>
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<tr>
<td>NE 350</td>
<td>Work-term Report 2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>NE 352</td>
<td>Surfaces and Interfaces</td>
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</table>

**Three Two Technical Electives**

**4A Fall**

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Hours</th>
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<tbody>
<tr>
<td>NE 408</td>
<td>Nanosystems Design Project</td>
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**Two Senior Laboratory course electives selected from:**

<table>
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<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Hours</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE 454A</td>
<td>Nano-instrumentation Laboratory 1</td>
<td>0</td>
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<tr>
<td>NE 454B</td>
<td>Nano-electronics Laboratory 1</td>
<td>0</td>
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**4B Winter**

<table>
<thead>
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<th>Course Code</th>
<th>Title</th>
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<th>Hours</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>NE 409</td>
<td>Nanosystems Design Project and Symposium</td>
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<tr>
<td>NE 450</td>
<td>Work-term Report 3</td>
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**Two Senior Laboratory course electives selected from:**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Hours</th>
<th>Remarks</th>
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<td>Nano-instrumentation Laboratory 2</td>
<td>0</td>
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<tr>
<td>NE 455B</td>
<td>Nano-electronics Laboratory 2</td>
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</tbody>
</table>

**CSE Complementary Studies Elective**

**Three Technical Electives**
Technical Electives

The following courses are normally offered annually. For a list of courses available on a specific term, consult the nanotechnology engineering undergraduate co-ordinator. The department 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.
<table>
<thead>
<tr>
<th>Course and Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
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<tbody>
<tr>
<td>NE 335 Soft Nanomaterials</td>
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<td>NE 344 Electronic Circuits</td>
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<td>NE 345 Photonic Materials and Devices</td>
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<tr>
<td>NE 352 Surfaces and Interfaces</td>
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<tr>
<td>NE 353 Nanoprobing and Lithography</td>
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<tr>
<td>NE 381 Introduction to Nanoscale Biosystems</td>
<td>3</td>
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<tr>
<td>NE 451 Simulation Methods</td>
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<tr>
<td>NE 452 Special Topics in Nanoscale Simulations</td>
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<tr>
<td>NE 453 Special Topics in Nanotechnology Engineering†</td>
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<td>NE 459 Nanotechnology Engineering Research Project</td>
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<tr>
<td>NE 461 Micro and Nano-instrumentation</td>
<td>3</td>
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<tr>
<td>NE 466 Tactile Sensors and Transducers</td>
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<tr>
<td>NE 469 Special Topics in Micro and Nano-instrumentation†</td>
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<tr>
<td>NE 471 Nano-electronics</td>
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<tr>
<td>NE 476 Organic Electronics</td>
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<tr>
<td>NE 479 Special Topics in Nanoelectronics †</td>
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<td>NE 481 Nanomedicine and Nanobiotechnology</td>
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<tr>
<td>NE 486 Biosensors</td>
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<tr>
<td>NE 487 Microfluidic and Nanobiotechnological Systems</td>
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<tr>
<td>NE 488 Biomaterials and Biomedical Design</td>
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<tr>
<td>NE 489 Special Topics in Nanoscale Biosystems †</td>
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<tr>
<td>NE 491 Nanostructured Materials</td>
<td>3</td>
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<tr>
<td>NE 496 Nanomaterials for Electrochemical Energy Systems</td>
<td>3</td>
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</tr>
<tr>
<td>NE 499 Special Topics in Nanostructured Materials †</td>
<td>3</td>
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</tr>
</tbody>
</table>
NEW COURSES (for approval)

Dean of Engineering

Effective 01-SEP-2020

NE 466 (0.50) LEC Tactile Sensors and Transducers
[Offered: W, first offered Winter 2021]

Requisites:
Prereq: Level at least 3B Biomedical Engineering or Electrical Engineering or Nanotechnology Engineering. Antireq: NE 469 (Topic: Tactile Sensors)

Rationale:
NE 469 is a special topics course, which allows the course to be flexible in its contents, but where that variability has led to confusion with students and to headaches with respect to antirequisites and prerequisites. The popularity of NE 469 means that there is sufficient student demand to create dedicated courses, on a more regular basis, which will be much clearer for prospective students and administratively simpler in terms of requisites.

Effective 01-SEP-2020

NE 476 (0.50) LEC Organic Electronics

Requisites:
Prereq: Level at least 3B Electrical Engineering or Nanotechnology Engineering. Antireq: NE 479 (Topic: Organic Electronics); NE 499 (Topic: Materials 4 Printed Electronics)

Rationale:
NE 479 is a special topics course, which allows the course to be flexible in its contents, but where that variability has led to confusion with students and to headaches with respect to antirequisites and prerequisites. The popularity of NE 479 means that there is sufficient student demand to create dedicated courses, on a more regular basis, which will be much clearer for prospective students and administratively simpler in terms of requisites.
Effective 01-SEP-2020
NE  486 (0.50)  LEC  Biosensors
Introduction to biosensors. Chemical, optical, and pattern recognition-based sensing.

Requisites :
Prereq: Level at least 3B Biomedical Engineering or Nanotechnology Engineering. Antireq: NE 469 (Topic: DNA Biosensors and Nanotechnology)

Rationale :
NE 469 is a special topics course, which allows the course to be flexible in its contents, but where that variability has led to confusion with students and to headaches with respect to antirequisites and prerequisites. The popularity of NE 469 means that there is sufficient student demand to create dedicated courses, on a more regular basis, which will be much clearer for prospective students and administratively simpler in terms of requisites.

Effective 01-SEP-2020
NE  487 (0.50)  LEC  Microfluidic and Nanobiotechnological Systems

Requisites :
Prereq: NE 381; Level at least 3B Biomedical Engineering or Nanotechnology Engineering. Antireq: NE 479 (Topic: Microfluidic and Nanobiotechnological Systems)

Rationale :
NE 479 is a special topics course, which allows the course to be flexible in its contents, but where that variability has led to confusion with students and to headaches with respect to antirequisites and prerequisites. The popularity of NE 479 means that there is sufficient student demand to create dedicated courses, on a more regular basis, which will be much clearer for prospective students and administratively simpler in terms of requisites.

Effective 01-SEP-2020
NE  488 (0.50)  LEC  Biomaterials and Biomedical Design
An overview of nanomedicine and nanotechnology-based biomedical devices. Strategies and technologies for designing, testing, and manufacturing biomaterials and tissue-engineering products. Biological and clinical applications. Manufacturing
challenges and regulatory procedures for commercialization. [Offered: W, first offered Winter 2021]

Requisites : Prereq: NE 481; Level at least 3B Biomedical Engineering or Chemical Engineering or Nanotechnology Engineering. Antireq: BME 489 (Topic: Biocompatibility and Biomaterial Engineering); NE 489 (Topic: Biomaterials and Tissue Engineering)

Rationale : NE 489 is a special topics course, which allows the course to be flexible in its contents, but where that variability has led to confusion with students and to headaches with respect to antirequisites and prerequisites. The popularity of NE 489 means that there is sufficient student demand to create dedicated courses, on a more regular basis, which will be much clearer for prospective students and administratively simpler in terms of requisites.

Effective 01-SEP-2020

NE 496 (0.50) LEC Nanomaterials for Electrochemical Energy Systems

Requisites : Prereq: Level at least 3B Nanotechnology Engineering. Antireq: CHE 331, NE 499 (Topic: Nanomaterials and Sustainable Energy)

Rationale : NE 499 is a special topics course, which allows the course to be flexible in its contents, but where that variability has led to confusion with students and to headaches with respect to antirequisites and prerequisites. The popularity of NE 499 means that there is sufficient student demand to create dedicated courses, on a more regular basis, which will be much clearer for prospective students and administratively simpler in terms of requisites.

COURSE CHANGES (for approval)

Current Catalog Information

NE 100 (0.50) LAB, LEC, TST, TUT Introduction to Nanotechnology Engineering
An introduction to nanotechnology engineering and its applications. Basic engineering principles and methodology, including the roles of standards, safety, and intellectual property. The purpose, structure, format, and essential components of engineering technical reports. Introduction to the areas of nanomedicine, nanomaterials, and nanoelectronics. Professional development, including résumé skills, interview skills, and preparation for co-op terms. [Offered: F]
No Special Consent Required
Requisites:
Prereq: 1A Nanotechnology Engineering. Antireq: CHE 100, CIVE 125, ECE 100, ME 100, SYDE 101

Effective 01-SEP-2020

Description Change:
An introduction to nanotechnology engineering and its various applications from electronics to biology. Basic concepts related to nanomaterials and devices, fabrication approaches, and characterization methods. Introduction to engineering iterative design, computer aided design (CAD) and modelling. Application of CAD methods in relevant nanotechnology engineering problems. Engineering report preparation skills. [Offered: F]

Requisite Change:
Prereq: Level 1A Nanotechnology Engineering

Rationale:
The course description is revised to remove topics that are now covered in other courses (NE 102 and NE 109). The prerequisite is modified for consistency, and the antirequisites are removed due to minimal overlap in content with other concept courses in engineering.

Current Catalog Information
NE 334 (0.50) LEC, TUT Statistical Thermodynamics

No Special Consent Required
Requisites:

Effective 01-SEP-2020

Description Change:

Requisite Change:
Prereq: Level at least 3B Nanotechnology Engineering. Antireq: CHEM 400 (Topic: Statistical Mechanics), PHYS 359

Rationale:
The antirequisite is updated as CHEM 450 no longer exits. All 400-level CHEM special topics courses have been renumbered as CHEM 400. This course moved from 3A term (spring) last offered in spring 2020 to 3B term (fall) first offered fall 2021.

Current Catalog Information
NE 352 (0.50) LEC Surfaces and Interfaces
nanoscale structure formation/surface patterning, biological interfaces. [Offered: F]
No Special Consent Required
Requisites: Prereq: Level at least 3B Nanotechnology Engineering Antireq: CHEM 450 (topic: Surface Science and Nanotechnology)

Effective 01-SEP-2020
Requisite Change: Prereq: Level at least 3B Nanotechnology Engineering. Antireq: CHEM 400 (Topic: Surface Science and Nanotechnology)
Rationale: The antirequisite is updated as CHEM 450 no longer exits. All 400-level CHEM special topics courses have been renumbered as CHEM 400.

Current Catalog Information
NE 454A (0.25) LAB Nano-instrumentation Laboratory 1
Application of experimental tools and techniques in nano-instrumentation.
Experimental exercises involve circuit simulation and design, circuit prototyping, design of a driver circuit for a quartz crystal microbalance (QCM), printed circuit board (PCB) design and layout optimization, and the use of various characterization instrumentation. [Offered: F]
No Special Consent Required
Requisites: Prereq: 4A Nanotechnology Engineering

Effective 01-SEP-2020
Title Change: Nano-electronics Laboratory 1
Description Change: Application of experimental tools and techniques in nano-electronics.
Experimental exercises may involve circuit simulation and design, circuit prototyping, design of a driver circuit for a quartz crystal microbalance (QCM), printed circuit board (PCB) design and layout optimization, and the use of various characterization instrumentation. [Offered: F]
Rationale: The scope of the lab is closer to nano-electronics than to nano-instrumentation. The title and description revision reflects what is currently covered in the lab, and will ensure students select the lab that suits their interest without confusion.

Current Catalog Information
NE 454B (0.25) LAB Nano-electronics Laboratory 1
Application of experimental tools and techniques involved in nanotechnology.
Experimental exercises may involve simulation, design, optimization of micro-electro-mechanical-system (MEMS) devices, and the generation of a mask layout. [Offered: F]
No Special Consent Required
Requisites: Prereq: 4A Nanotechnology Engineering

Effective 01-SEP-2020
Title Change: Nano-instrumentation Laboratory 1
Rationale: The scope of the lab is closer to nano-instrumentation than to nano-electronics. The title revision reflects what is currently being covered in the lab, and will ensure students select the lab that suits their interest without confusion.
Current Catalog Information

**NE 455A (0.25) LAB** Nano-instrumentation Laboratory 2
Application of experimental tools and techniques in nano-instrumentation.
Experimental exercises involve printed circuit board (PCB) assembly and soldering, measurement of the formation of a nonanethiol self-assembled monolayer, determination of the partition coefficient for a solvent vapour into a monolayer-protected-cluster film deposited on a quartz crystal microbalance (QCM), and the use of various characterization methods. [Offered: W]

Requisites: Prereq: NE 454A; 4B Nanotechnology Engineering

Effective 01-SEP-2020
Title Change: Nano-electronics Laboratory 2
Description Change: Application of experimental tools and techniques employed in nanotechnology. Experimental exercises to complete the design cycle involve printed circuit board (PCB) assembly and soldering, measurement of the formation of a nonanethiol self-assembled monolayer, determination of the partition coefficient for a solvent vapour into a monolayer-protected-cluster film deposited on a quartz crystal microbalance (QCM), and the use of various characterization methods. These exercises also stress the safe handling of chemicals in the process. [Offered: W]
Rationale: The scope of the lab is closer to nano-electronics than to nano-instrumentation. The title and description revision reflects what is currently being covered in the lab, and will ensure students select the lab that suits their interest without confusion. This also shows the connection to the 4A lab.

Current Catalog Information

**NE 455B (0.25) LAB** Nano-electronics Laboratory 2
Application of experimental tools and techniques employed in nanotechnology.
Experimental exercises may involve microfabrication (photolithography, film deposition, and etching) and testing of micro-electro-mechanical-system (MEMS) devices. [Offered: W]

No Special Consent Required

Requisites: Prereq: NE 454B; 4B Nanotechnology Engineering

Effective 01-SEP-2020
Title Change: Nano-instrumentation Laboratory 2
Description Change: Application of experimental tools and techniques employed in nanotechnology. Experimental exercises may involve microfabrication (photolithography, film deposition, and etching) and testing of micro-electro-mechanical-system (MEMS) devices based on the design from NE 454B. These exercises also stress working safely in a clean-room environment. [Offered: W]
Rationale: The scope of the lab is closer to nano-instrumentation than to nano-electronics. The title and description revision reflects what is
currently covered in the lab, and will ensure students select the lab that suits their interest without confusion. This also shows the connection to the 4A lab.

Current Catalog Information

NE  455D  ( 0.25 )  LAB  Nanostructured Materials Laboratory 2
Application of experimental tools and techniques employed in nanomaterials. Experimental exercises investigate catalytic activity enhancement by nanoparticles in fuel cell reactions. This includes the use of synthetic chemistry protocols to prepare nanoparticles on multi-walled carbon nanotubes. The exercise also stresses safe handling of nanomaterials and the use of various characterization methods.
[Offered: W]
No Special Consent Required
Requisites : Prereq: NE 454D; 4B Nanotechnology Engineering
Effective  01-SEP-2020
Description Change: Application of experimental tools and techniques employed in nanomaterials. Experimental exercises may investigate and design the production and performance of electronic double layer capacitors (EDLC) for battery applications through the use of dispersion and mixing protocols to prepare carbon materials. Performance of the materials may be quantified using defined testing methods for measurement of electrical storage metrics. The exercise also stresses safe handling of nanomaterials. [Offered: W]
Rationale : The description is updated and topics removed that are covered in other labs (e.g., NE 226L, NE 320L, and NE 454D). This revision reflects what is currently covered in the lab, and will ensure students select the lab that suits their interest without confusion. This also shows the connection to the 4A lab.

COURSE INACTIVATIONS  (for approval)

Effective  01-SEP-2020
NE  469  ( 0.50 )  Special Topics in Micro and Nano-instrumentation
Rationale : This special topics course is inactivated, and new courses are created from popular topics (e.g., NE 466, and NE 486). Any other topics will be offered under NE 453.

Effective  01-SEP-2020
NE  479  ( 0.50 )  Special Topics in Nanoelectronics
Rationale : This special topics course is inactivated, and new courses created from popular topics (e.g., NE 476, and NE 487). Other topics will be offered under NE 453.

Effective  01-SEP-2020
NE  489  ( 0.50 )  Special Topics in Nanoscale Biosystems
Rationale: This special topics course is inactivated, and a new course created from popular topics (e.g., NE 488). Other topics will be offered under NE 453.

Effective 01-SEP-2020
NE 499 (0.50) Special Topics in Nanostructured Materials

Rationale: This special topics course is inactivated, and a new course created from popular topics (e.g., NE 496). Other topics will be offered under NE 453.
Architectural Engineering

North Americans spend more than 90% of their lives inside buildings. During this time, their productivity and quality of life are directly affected by the nature of the enclosed environment. Buildings also represent one of the largest components of any industrialized country's capital wealth. The resources used and the contaminants released by the construction and operation of buildings are now widely understood to have widespread impact on the environment and the economy. Future buildings will need to be more energy efficient, durable, sustainable, low maintenance, and flexible than existing buildings. Today there already exists an enormous portfolio of buildings that require repair, renovation, and rehabilitation. Managing, repairing, replacing, and retrofitting existing buildings will become an increasingly important activity in the future.

There is a pressing need to support this massive and changing industry with the proper technical knowledge and management skills. The Architectural Engineering curriculum is designed to address this need by providing the necessary fundamentals of mathematics and the natural sciences, as well as to provide perspectives from the fields of the social sciences and humanities.

Architectural Engineering has “Design from Day One” “Communication, Collaboration, and Design” as its mantra. A common Architectural Engineering class held in a studio setting is the core of each term and knits together issues such as design, aesthetics, culture, environment, and professionalism in the context of engineered buildings. A studio teaching experience, common in design-centric plans such as architecture and industrial design, allows for enhanced peer-learning, better collaborative work, inspiration from surroundings, rapid modelling and prototyping, while encouraging hands-on investigations and exploration. Another of the distinctive features of the curriculum is its 3A and 3B academic terms, during which students take their classes at the University of Waterloo Cambridge campus, immersed in the School of Architecture, working alongside architecture students.

Architectural Engineering is designed to produce graduates with broad, yet technically deep, skills capable of responding to the unique and emerging challenges currently confronting the building industry. Exposing graduates to a world of design excellence through this unique academic plan will ensure that the skills taught will be used to develop the best solutions, while teaching communication in multiple media will guarantee that these solutions are understood and supported by all of the stakeholders in the building industry. The curriculum considers sustainability and environmental concerns of the built environment to be a fundamental part of all engineering design. As such, sustainability is not taught as a separate course, but is pervasive through all design decisions and an input or constraint to all relevant analysis.

Academic Curriculum

The following curriculum is applicable to students entering Architectural Engineering in the fall 2019 term. Note that 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 125 Architectural Graphics Studio
AE 199 Seminar
GENE 123 AE 123 Electrical Circuits and Instrumentation
MATH 118 Calculus 2 for Engineering

Term 2A (Winter)

AE 200 Structural 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 Studio
AE 265 Structure and Properties of Materials
AE 299 Seminar
CSE 3 or TE 1 Approved Complementary Studies Elective or Technical Elective
WKRP 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 398 Seminar
ARCH 277  Timber: Design, Structure and Construction for Engineers
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

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

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

- Mathematical Foundations
- Natural Sciences
- Engineering Sciences
- Engineering Design
- 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.

{change order – cover CSEs first, then TEs, then specializations, and options}

Complementary Studies Electives

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 CSE courses are organized on a Faculty basis and detailed in this Calendar, under the Complementary Studies in the Faculty of Engineering page. 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. At least One TE must be from TE List D (Natural Science Technical Electives)

Up to two TEs may be technical courses from other plans; such courses must have sufficiently advanced technical content to be allowed, and will be counted as List B TEs. Further information is available from the CEE Undergraduate Office or CEE website. 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 professor if the prerequisites have
not been satisfied.

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](#).

Key for **TE** List A, B, and C:

Term courses are offered: F=Fall term, W=Winter term, S=Spring term

**TE List A - Architectural Engineering Technical Electives (choose at least three)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE 301</td>
<td>Building Enclosure Systems</td>
<td>W</td>
</tr>
<tr>
<td>AE 315</td>
<td>Building Structural Systems</td>
<td>W</td>
</tr>
<tr>
<td>AE 405</td>
<td>Building Performance Measurement Lab</td>
<td>S</td>
</tr>
<tr>
<td>AE 450</td>
<td>Building Service Systems</td>
<td>S</td>
</tr>
<tr>
<td>AE 495</td>
<td>Design Intensive Special Topics in Architectural Engineering</td>
<td>as offered</td>
</tr>
<tr>
<td>ARCH 570</td>
<td>Special Topics in Building Technology and Environmental</td>
<td>W</td>
</tr>
<tr>
<td>ME 452</td>
<td>Energy Transfer in Buildings</td>
<td>W</td>
</tr>
</tbody>
</table>

**TE List B - Engineering Design Intensive Technical Electives (choose at least two)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARCH 463</td>
<td>Integrated Environmental Systems</td>
<td>S</td>
</tr>
<tr>
<td>CIVE 413</td>
<td>Structural Steel Design</td>
<td>S</td>
</tr>
<tr>
<td>CIVE 414</td>
<td>Structural Concrete Design</td>
<td>S</td>
</tr>
<tr>
<td>CIVE 415</td>
<td>Structural System Design</td>
<td>W</td>
</tr>
<tr>
<td>CIVE 460</td>
<td>Engineering Biomechanics</td>
<td>W</td>
</tr>
<tr>
<td>CIVE 495</td>
<td>Design Intensive Special Topics in Civil Engineering</td>
<td>as offered</td>
</tr>
<tr>
<td>CIVE 497</td>
<td>Special Topics in Civil Engineering</td>
<td>F</td>
</tr>
<tr>
<td>CIVE 512</td>
<td>Rehabilitation of Structures</td>
<td>W</td>
</tr>
<tr>
<td>CIVE 596</td>
<td>Construction Engineering</td>
<td>S</td>
</tr>
</tbody>
</table>

**TE List C - Engineering Technical Electives**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE 497</td>
<td>Special Topics in Architectural Engineering</td>
<td>as offered</td>
</tr>
<tr>
<td>CIVE 422</td>
<td>Finite Element Analysis</td>
<td>W</td>
</tr>
</tbody>
</table>
List D - Natural Science Technical Electives (choose one)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 130</td>
<td>Introductory Cell Biology</td>
<td>F,W,S</td>
</tr>
<tr>
<td>BIOL 150</td>
<td>Organismal and Evolutionary Ecology</td>
<td>F</td>
</tr>
<tr>
<td>BIOL 240</td>
<td>Fundamentals of Microbiology</td>
<td>F,W,S</td>
</tr>
<tr>
<td>BIOL 273</td>
<td>Principles of Human Physiology 1</td>
<td>F,W</td>
</tr>
<tr>
<td>CHE 161</td>
<td>Engineering Biology</td>
<td>W,S</td>
</tr>
<tr>
<td>CHEM 209</td>
<td>Introductory Spectroscopy and Structure</td>
<td>F</td>
</tr>
<tr>
<td>CHEM 262</td>
<td>Organic Chemistry for Engineering</td>
<td>F,W</td>
</tr>
<tr>
<td>EARTH 221</td>
<td>Geochemistry 1</td>
<td>W,S</td>
</tr>
<tr>
<td>EARTH 270</td>
<td>Disasters and Natural Hazards</td>
<td>W</td>
</tr>
<tr>
<td>EARTH 281</td>
<td>Geological Impacts on Human Health</td>
<td>W</td>
</tr>
<tr>
<td>ENVS 200</td>
<td>Field Ecology</td>
<td>W,S</td>
</tr>
<tr>
<td>KIN 100</td>
<td>Human Anatomy: Limbs and Trunk</td>
<td>W</td>
</tr>
<tr>
<td>SCI 207</td>
<td>Physics, the Universe, and Everything</td>
<td>W</td>
</tr>
<tr>
<td>SCI 238</td>
<td>Introductory Astronomy</td>
<td>F,W,S</td>
</tr>
</tbody>
</table>

Complementary Studies Electives

Two Complementary Studies Elective (CSE) 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), AE 101 (List C), AE 392 (List B), and AE 491 (List D). The CSE courses are organized on a Faculty basis and detailed in this Calendar, under the Complementary Studies in the Faculty of Engineering page. 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

Specializations

The Faculty of Engineering recognizes 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.

The Architectural Engineering plan has two specializations recognized by the Faculty of Engineering:

- Building Structures Specialization
- Building Systems Specialization

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 an average of at least 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 course requirements are:

1. At least five TEs from the list below.
2. At least one of CIVE 413 or CIVE 414 must be taken in the five TEs.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 413</td>
<td>Structural Steel Design</td>
<td>S</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 414</td>
<td>Structural Concrete Design</td>
<td>S</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 415</td>
<td>Structural System Design</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 422</td>
<td>Finite Element Analysis</td>
<td>W</td>
<td>C</td>
</tr>
<tr>
<td>CIVE 460</td>
<td>Engineering Biomechanics</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 505</td>
<td>Structural Dynamics</td>
<td>S</td>
<td>C</td>
</tr>
<tr>
<td>CIVE 512</td>
<td>Rehabilitation of Structures</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 596</td>
<td>Construction Engineering</td>
<td>S</td>
<td>B</td>
</tr>
</tbody>
</table>

Building Systems Specialization

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE 301</td>
<td>Building Enclosure Systems</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>AE 315</td>
<td>Building Structural Systems</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>AE 405</td>
<td>Building Performance Measurement Lab</td>
<td>S</td>
<td>A</td>
</tr>
<tr>
<td>AE 450</td>
<td>Building Service Systems</td>
<td>S</td>
<td>A</td>
</tr>
<tr>
<td>AE 495</td>
<td>Design Intensive Special Topics in Architectural Engineering</td>
<td>F,S</td>
<td>A</td>
</tr>
</tbody>
</table>
Faculty Options

The Faculty of Engineering recognizes options within the BASc degree. Students who satisfy the option requirements (courses and grades) will have the option designation shown on their transcript and diploma. Options are intended to recognize success in a field of study outside of the basic degree. Consequently, students must usually take extra courses to complete an option.

Students in Architectural Engineering are often interested in the Entrepreneurship Option, Environmental Engineering Option, International Studies Option, Management Sciences Option, and Statistics Option. Complete details of designated options available to Engineering students are provided in this Calendar in the section entitled Options, Specializations and Electives for Engineering Students. Students who satisfy the option requirements will have the appropriate designations appear on their transcript and diploma. The following option may be of interest to Architectural Engineering students. (Note: To qualify for these options, students must achieve a grade of at least 50% in each course and must obtain a cumulative average of 60% or more in these courses.)

Management Sciences Option

The Management Sciences Option provides an understanding of the issues, concepts, and techniques related to the management of technology. The Option consists of a sequence of six courses. Students who wish to follow the Management Sciences Option must declare their intent before starting the 2B term. For further details see the Management Sciences website.

Accelerated Master's Program in Engineering

The Faculty of Engineering offers an Accelerated Master's Program. See Accelerated Master's Programs in Engineering for more details.
NEW COURSES  (for approval)

Civil and Environmental Engineering

**Effective 01-SEP-2020**

AE 123 (0.50)  LAB, LEC, TUT  Electrical Circuits and Instrumentation

Charge, current, and voltage. Voltage and current sources, resistors, capacitors, and inductors. Ohm's Law, Kirchhoff's Laws, nodal analysis, instrumentation amplifier circuits, impedance. Function and characteristics of basic electrical transducers. Resolution, precision, and accuracy. Basics of data acquisition. [Note: Normally labs are held alternate weeks. Offered: AE 123 (S), CIVE 123 (W), ENVE 123 (S), GEOE 123 (S)]

Requisites : Prereq: Level at least 1B Architectural Engineering. Antireq: GENE 123, ME 123

Cross-listed as: CIVE 123 ENVE 123 GEOE 123

Rationale : This course replaces GENE 123 in the Civil, Architectural, Environmental, and Geological curriculum with two small changes in the course description. Thevenin and Norton models, and time responses are removed. This change allows the department of Civil and Environmental Engineering to directly control the course content.

**Effective 01-SEP-2020**

AE 199 (0.00)  SEM  Seminar

General seminar. [Offered: S]

Requisites : Prereq: Level at least 1B Architectural Engineering

Rationale : The need has been identified for a class professor hour general seminar each term from 1B-4B, similarly to what is done in civil engineering. This hour will be used heavily at the start of the term, to disseminate class announcements and collect co-op reports. It will also ensure a time is available for guest speakers to occasionally come in and give talks throughout the term, which may be of interest to the class.

**Effective 01-SEP-2020**

AE 298 (0.00)  SEM  Seminar

General seminar. [Offered: W]

Requisites : Prereq: Level at least 2A Architectural Engineering

Rationale : The need has been identified for a class professor hour general seminar each term from 1B-4B, similarly to what is done in civil engineering. This hour will be used heavily at the start of the term, to disseminate class announcements and collect co-op reports. It will also ensure a time is available for guest speakers to occasionally come in and give talks.
throughout the term, which may be of interest to the class.

Effective 01-SEP-2020
AE  299 ( 0.00 )  SEM       Seminar

Requisites : Prereq: Level at least 2B Architectural Engineering
Rationale : The need has been identified for a class professor hour general seminar each term from 1B-4B, similarly to what is done in civil engineering. This hour will be used heavily at the start of the term, to disseminate class announcements and collect co-op reports. It will also ensure a time is available for guest speakers to occasionally come in and give talks throughout the term, which may be of interest to the class.

Effective 01-SEP-2020
AE  398 ( 0.00 )  SEM       Seminar

Requisites : Prereq: Level at least 3A Architectural Engineering
Rationale : The need has been identified for a class professor hour general seminar each term from 1B-4B, similarly to what is done in civil engineering. This hour will be used heavily at the start of the term, to disseminate class announcements and collect co-op reports. It will also ensure a time is available for guest speakers to occasionally come in and give talks throughout the term, which may be of interest to the class.

Effective 01-SEP-2020
AE  399 ( 0.00 )  SEM       Seminar

Requisites : Prereq: Level at least 3B Architectural Engineering
Rationale : The need has been identified for a class professor hour general seminar each term from 1B-4B, similarly to what is done in civil engineering. This hour will be used heavily at the start of the term, to disseminate class announcements and collect co-op reports. It will also ensure a time is available for guest speakers to occasionally come in and give talks throughout the term, which may be of interest to the class.

Effective 01-SEP-2020
AE  495 ( 0.50 )  LEC, TUT Design Intensive Special Topics in Architectural Engineering

A special topics course on design intensive advanced topics in architectural engineering is offered from time to time, when resources are available. For the current offering, inquire at the Department.

Rationale : This special topics course will mirror the new CIVE 495 course in civil engineering. This course offers a special topics course that meets the
design intensive technical elective (TE) requirement.

**Effective 01-SEP-2020**

**AE 497 (0.50) LEC, TUT**

Special Topics in Architectural Engineering

A special topics course on advanced topics in architectural engineering is offered from time to time, when resources are available. For the current offering, inquire at the Department.

**Rationale:** This special topics course is created to mirror CIVE 497 in civil engineering. This course offers the possibility of a special topics course that meets the design intensive technical elective (TE) requirement.

**Effective 01-SEP-2020**

**AE 498 (0.00) SEM**

Seminar

General seminar. [Offered: S]

**Requisites:** Prereq: Level at least 4A Architectural Engineering

**Rationale:** The need has been identified for a class professor hour general seminar each term from 1B-4B, similarly to what is done in civil engineering. This hour will be used heavily at the start of the term, to disseminate class announcements and collect co-op reports. It will also ensure a time is available for guest speakers to occasionally come in and give talks throughout the term, which may be of interest to the class.

**Effective 01-SEP-2020**

**AE 499 (0.00) SEM**

Seminar

General seminar. [Offered: W]

**Requisites:** Prereq: 4B Architectural Engineering

**Rationale:** The need has been identified for a class professor hour general seminar each term from 1B-4B, similarly to what is done in civil engineering. This hour will be used heavily at the start of the term, to disseminate class announcements and collect co-op reports. It will also ensure a time is available for guest speakers to occasionally come in and give talks throughout the term, which may be of interest to the class.

**Effective 01-SEP-2020**

**CIVE 123 (0.50) LAB, LEC, TUT**

Electrical Circuits and Instrumentation

Charge, current, and voltage. Voltage and current sources, resistors, capacitors, and inductors. Ohm's Law, Kirchhoff's Laws, nodal analysis, instrumentation amplifier circuits, impedance. Function and characteristics of basic electrical transducers. Resolution, precision, and accuracy. Basics of data acquisition. [Note: Normally labs are held alternate weeks. Offered: AE 123 (S), CIVE 123 (W), ENVE 123 (S), GEOE 123 (S)]

**Requisites:** Prereq: Level at least 1B Civil Engineering. Antireq: GENE 123, ME 123
Cross-listed as: AE 123  ENVE 123  GEOE 123

Rationale: This course replaces GENE 123 in the Civil, Architectural, Environmental, and Geological curriculum with two small changes in the course description. Thevenin and Norton models, and time responses are removed. This change allows the department of Civil and Environmental Engineering to directly control the course content.

Effective 01-SEP-2020

CIVE 495 (0.50) LEC, TUT Design Intensive Special Topics in Civil Engineering

A special course on design intensive advanced topics in civil engineering is offered from time to time, when resources are available. For the current offering, inquire at the Department.

Rationale: A special topics course that meets the design intensive technical elective (TE) requirement in Civil and Environmental Engineering. This course complements the existing CIVE 497 Special topics in Civil Engineering that is not design intensive.

Effective 01-SEP-2020

GEOE 123 (0.50) LAB, LEC, TUT Electrical Circuits and Instrumentation

Charge, current, and voltage. Voltage and current sources, resistors, capacitors, and inductors. Ohm's Law, Kirchhoff's Laws, nodal analysis, instrumentation amplifier circuits, impedance. Function and characteristics of basic electrical transducers. Resolution, precision, and accuracy. Basics of data acquisition. [Note: Normally labs are held alternate weeks. Offered: AE 123 (S), CIVE 123 (W), ENVE 123 (S), GEOE 123 (S)]

Requisites: Prereq: Level at least 1B Geological Engineering. Antireq: GENE 123, ME 123

Cross-listed as: CIVE 123 AE 123  ENVE 123

Rationale: This course replaces GENE 123 in the Civil, Architectural, Environmental, and Geological curriculum with two small changes in the course description. Thevenin and Norton models, and time responses are removed. This change allows the department of Civil and Environmental Engineering to directly control the course content.

Effective 01-SEP-2020

GEOE 495 (0.50) LEC, TUT Design Intensive Special Topics in Geological Engineering

A special topics course on design intensive advanced topics in geological engineering is offered from time to time, when resources are available. For the current offering, inquire at the Department.

Rationale: A special topics course that meets the design intensive technical elective (TE) requirements in Geological Engineering.
GEOE 497 (0.50) LEC, TUT Special Topics in Geological Engineering
A special topics course on advanced topics in geological engineering is offered from time to time, when resources are available. For the current offering, inquire at the Department.

Rationale:
A special topics course in Geological Engineering; replaces CIVE 497 Special Topics in Civil Engineering in the geological engineering curriculum.

Dean of Engineering

Effective 01-SEP-2020
ENVE 123 (0.50) LAB, LEC, TUT Electrical Circuits and Instrumentation
Charge, current, and voltage. Voltage and current sources, resistors, capacitors, and inductors. Ohm's Law, Kirchhoff's Laws, nodal analysis, instrumentation amplifier circuits, impedance. Function and characteristics of basic electrical transducers. Resolution, precision, and accuracy. Basics of data acquisition. [Note: Normally labs are held alternate weeks. Offered: AE 123 (S), CIVE 123 (W), ENVE 123 (S), GEOE 123 (S)]

Requisites:
Prereq: Level at least 1B Environmental Engineering. Antireq: GENE 123, ME 123

Cross-listed as:
CIVE 123 AE 123 GEOE 123

Rationale:
This course replaces GENE 123 in the Civil, Architectural, Environmental, and Geological curriculum with two small changes in the course description. Thevenin and Norton models, and time responses are removed. This change allows the department of Civil and Environmental Engineering to directly control the course content.

Effective 01-SEP-2020
ENVE 495 (0.50) LEC, TUT Design Intensive Special Topics in Environmental Engineering
A special topics course on design intensive advanced topics in environmental engineering is offered from time to time, when resources are available. For the current offering, inquire at the Department.

Rationale:
A special topics course that meets the design intensive technical elective (TE) requirements in Environmental Engineering.

Effective 01-SEP-2020
ENVE 497 (0.50) LEC, TUT Special Topics in Environmental Engineering
A special topics course on advanced topics in environmental engineering is offered from time to time, when resources are available. For the current offering, inquire at the Department.

Rationale:
A special topics course in environmental engineering; replaces CIVE 497
Special Topics in Civil Engineering in the environmental engineering curriculum.

COURSE CHANGES (for approval)

Civil and Environmental Engineering

Current Catalog Information
CIVE 505 (0.50) LEC, TUT Structural Dynamics
- Dynamics of discrete and continuous structures. Free and forced vibrations of single and multi-degree of freedom systems. Shock loads, earthquake loads, response spectra.
- Analysis and design of frames for shock and earthquake loads. [Offered: W]
- No Special Consent Required
- Requisites: Prereq: (AE 303 or CIVE 303), (AE 223 or CIVE 222); Level at least 3B Architectural or Civil Engineering

Effective 01-SEP-2020
Description Change:
Term of offering only:
- Dynamics of discrete and continuous structures. Free and forced vibrations of single and multi-degree of freedom systems. Shock loads, earthquake loads, response spectra. Analysis and design of frames for shock and earthquake loads. [Offered: S]
- Rationale: The term offered is revised so students can take the course in 4A instead of 4B; no reason to wait until 4B; change will improve structural dynamics components in applicable capstone design projects.

Current Catalog Information
CIVE 542 (0.50) LAB, LEC Pavement Structural Design
- Pavement design, soil identification, subgrade design, base courses, flexible pavement design, design and testing of asphaltic concrete mixes, surface treatments.
- [Offered: W]
- No Special Consent Required
- Requisites: Prereq: CIVE 353; Level at least 3B Civil or Geological Engineering

Effective 01-SEP-2020
Component Change: LEC, TUT
Rationale:
- The LAB hour is assigned a classroom and used primarily as a tutorial, therefore, the secondary meet should be a TUT rather than a LAB.

End of Report
Civil Engineering

Additional Areas of Study

Alternatively, the student can choose a more general pattern of study involving courses from several topic areas, or a program outside the traditional civil engineering field. For instance, with the approval of the associate chair for undergraduate studies, the student may augment the Civil Engineering course curriculum with elective courses from: public administration, planning, management science, business administration, bioengineering, environmental health, and others.

To this end, the Civil Engineering curriculum has been designed to allow the maximum possible flexibility while still meeting the requirements for the professional degree. The curricula of the Civil Engineering, Environmental Engineering, and Geological Engineering plans are common in the first year to allow transfer among the three plans up to the end of first year. The Civil Engineering curriculum enables the students to conduct engineering analysis and design, to perform risk and life cycle analysis, and asset management, and to evaluate the impact of engineering work on the environment.

The profession of civil engineering is involved with the creation, operation, and maintenance of structures associated with water resources, transportation, power generation, and a wide range of industrial, commercial and institutional buildings and complexes including whole urban structures. The activities include investigation, planning design, construction, and evaluation.

Vocationally, a civil engineer may focus in such areas as biomechanics, solid mechanics, fracture mechanics, elasticity, building structures, bridges, hydrology, hydraulics, sanitation (public health), industrial wastes, water resource structures, irrigation and drainage, inland waterways, harbours, aerospace, highways (roads and streets), railroads, pipelines, geology, meteorology, soil mechanics, foundations, tunnelling (rock mechanics), surveying and cartography, urban and regional planning and overall project planning. A civil engineering education may also be combined with another discipline or profession, such as economics, law, medicine, or biology.

The civil engineer, regardless of whether they are a generalist or a specialist, draws heavily upon the work of the physical and social sciences, other professions and other branches of engineering. Moreover, as engineers have become involved in many interdisciplinary activities over the last decade, the job demarcation between boundaries of engineering has become much less restrictive. Certainly one of the advantages of completing a Civil Engineering plan is that it allows professional registration while simultaneously providing a basis for further study and professional development in a large variety of fields.

Academic Curriculum

Legend

CSE is a Complementary Studies Elective course
TE is a Technical Elective course
* Must be a TE if CSE is selected in a previous term, and vice versa

**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 153 Earth Engineering
- CIVE 199 Seminar
- GENE 123 CIVE 123 Electrical Circuits and Instrumentation
- 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

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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

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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

---

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
Electives

Each student is 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.

- Mathematical foundations
- Natural sciences
- Engineering sciences
- Engineering design
- 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

Three 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), CIVE 392 (List B) and CIVE 491 (List D). The CSE courses are organized on a Faculty basis and detailed in this Calendar, under the Complementary Studies in the Faculty of Engineering page. 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)

Up to two TEs may be technical courses from other plans; such courses must have sufficiently advanced technical content to be allowed, and will be counted as List B TEs. Further information is available from the CEE Undergraduate Office or CEE website. 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 professor if the prerequisites have not been satisfied.

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.

**Key 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)

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 343</td>
<td>Traffic Simulation Modelling and Applications</td>
</tr>
<tr>
<td>CIVE 354</td>
<td>Geotechnical Engineering 2</td>
</tr>
<tr>
<td>CIVE 415</td>
<td>Structural System Design</td>
</tr>
<tr>
<td>CIVE 413</td>
<td>Structural Steel Design</td>
</tr>
<tr>
<td>CIVE 414</td>
<td>Structural Concrete Design</td>
</tr>
<tr>
<td>CIVE 415</td>
<td>Structural System Design</td>
</tr>
<tr>
<td>CIVE 460</td>
<td>Engineering Biomechanics</td>
</tr>
<tr>
<td>CIVE 512</td>
<td>Rehabilitation of Structures</td>
</tr>
<tr>
<td>CIVE 542</td>
<td>Pavement Structural Design</td>
</tr>
<tr>
<td>CIVE 554</td>
<td>Geotechnical Engineering 3</td>
</tr>
<tr>
<td>CIVE 583</td>
<td>Design of Urban Water Systems</td>
</tr>
<tr>
<td>CIVE 413</td>
<td>Structural Steel Design</td>
</tr>
<tr>
<td>CIVE 414</td>
<td>Structural Concrete Design</td>
</tr>
<tr>
<td>CIVE 596</td>
<td>Construction Engineering</td>
</tr>
</tbody>
</table>

**Course**

| CIVE 343 | Traffic Simulation Modelling and Applications       |
| CIVE 354 | Geotechnical Engineering 2                          |
| CIVE 413 | Structural Steel Design                             |
| CIVE 414 | Structural Concrete Design                          |
| CIVE 415 | Structural System Design                            |
| CIVE 460 | Engineering Biomechanics                            |

**Term**

| F        | F        |
| S        | S        |
| W        | W        |
### CIVE 495
Design Intensive Special Topics in Civil Engineering

### CIVE 512
Rehabilitation of Structures

### CIVE 542
Pavement Structural Design

### CIVE 554
Geotechnical Engineering 3

### CIVE 583
Design of Urban Water Systems

### CIVE 596
Construction Engineering

### EARTH 438
Engineering Geology

### ENVE 577
Engineering for Solid Waste Management

### SYDE 533
Conflict Resolution

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**TE List B - Technical Electives (choose a maximum of four)**

*Table sorted by course; term offering on right; new entries: EARTH 444, 458, GEOG 209, 305, 371, 381, ME 559, Plan 416, 477; remove ARCH 277*

<table>
<thead>
<tr>
<th>Term</th>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>CIVE 306</td>
<td>Mechanics of Solids 3</td>
</tr>
<tr>
<td>F</td>
<td>ENVE 277</td>
<td>Air Quality Engineering</td>
</tr>
<tr>
<td>F</td>
<td>ENVE 279</td>
<td>Energy and the Environment</td>
</tr>
<tr>
<td>W</td>
<td>CIVE 422</td>
<td>Finite Element Analysis</td>
</tr>
<tr>
<td>W</td>
<td>CIVE 440</td>
<td>Transit Planning and Operations</td>
</tr>
<tr>
<td>W</td>
<td>CIVE 505</td>
<td>Structural Dynamics</td>
</tr>
<tr>
<td>W</td>
<td>CIVE 507</td>
<td>Building Science and Technology</td>
</tr>
<tr>
<td>W</td>
<td>ENVE 326</td>
<td>Biological Processes</td>
</tr>
<tr>
<td>W</td>
<td>ENVE 383</td>
<td>Advanced Hydrology and Hydraulics</td>
</tr>
<tr>
<td>W</td>
<td>ENVE 573</td>
<td>Contaminant Transport</td>
</tr>
<tr>
<td>S</td>
<td>ARCH 277</td>
<td>Timber: Design, Structure and Construction for Engineers</td>
</tr>
<tr>
<td>S</td>
<td>CIVE 484</td>
<td>Physical Infrastructure Planning</td>
</tr>
</tbody>
</table>

See CIVE 497

Special Topics in Civil Engineering (as offered)

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<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 306</td>
<td>Mechanics of Solids 3</td>
<td>F</td>
</tr>
<tr>
<td>CIVE 422</td>
<td>Finite Element Analysis</td>
<td>W</td>
</tr>
<tr>
<td>CIVE 440</td>
<td>Transit Planning and Operations</td>
<td>W</td>
</tr>
<tr>
<td>CIVE 484</td>
<td>Physical Infrastructure Planning</td>
<td>S</td>
</tr>
<tr>
<td>CIVE 497</td>
<td>Special Topics in Civil Engineering</td>
<td>S</td>
</tr>
<tr>
<td>CIVE 505</td>
<td>Structural Dynamics</td>
<td>S</td>
</tr>
<tr>
<td>CIVE 507</td>
<td>Building Science and Technology</td>
<td>W</td>
</tr>
<tr>
<td>EARTH 444</td>
<td>Applied Wetland Science</td>
<td>F</td>
</tr>
<tr>
<td>EARTH 458</td>
<td>Physical Hydrogeology</td>
<td>F.S</td>
</tr>
</tbody>
</table>
Notes on List B:

1. Up to two List B TEs may be technical courses from other plans subject to the approval of the CEE Undergraduate Office. Further information is available from the CEE Undergraduate Office or CEE website.

2. Special Topics Courses (CIVE 497) are offered as resources and faculty interests permit. Students should consult the CEE Undergraduate Office or CEE website for upcoming topics.

**TE List C - Natural Science Technical Electives (choose one)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 150</td>
<td>Organismal and Evolutionary Ecology</td>
<td>F</td>
</tr>
<tr>
<td>BIOL 130</td>
<td>Introductory Spectroscopy and Structure</td>
<td>F</td>
</tr>
<tr>
<td>BIOL 273</td>
<td>Principles of Human Physiology I</td>
<td>F,W</td>
</tr>
<tr>
<td>CHEM 209</td>
<td>Organic Chemistry for Engineering</td>
<td>F,W,S</td>
</tr>
<tr>
<td>CHEM 262</td>
<td>Introductory Cell Biology</td>
<td>F,W,S</td>
</tr>
<tr>
<td>BIOL 130</td>
<td>Introductory Astronomy</td>
<td>F,W,S</td>
</tr>
<tr>
<td>EARTH 270</td>
<td>Disasters and Natural Hazards</td>
<td>F,W,S</td>
</tr>
<tr>
<td>EARTH 281</td>
<td>Geological Impacts on Human Health</td>
<td>F,W,S</td>
</tr>
<tr>
<td>SCI 100</td>
<td>Human Anatomy: Limbs and Trunk</td>
<td>F,W,S</td>
</tr>
<tr>
<td>SCI 207</td>
<td>Physics, the Universe, and Everything</td>
<td>F,W,S</td>
</tr>
<tr>
<td>CHE 161</td>
<td>Engineering Biology</td>
<td>F,W,S</td>
</tr>
<tr>
<td>EARTH 221</td>
<td>Geochemistry I</td>
<td>F,W,S</td>
</tr>
<tr>
<td>ENVS 200</td>
<td>Field Ecology</td>
<td>F,W,S</td>
</tr>
</tbody>
</table>
Complementary Studies Electives

Three complementary studies elective (CSE) 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), CIVE 392 (List B) and CIVE 491 (List D). The CSE courses are organized on a Faculty basis and detailed in this Calendar, under the Complementary Studies in the Faculty of Engineering page. 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

Specializations

The Faculty of Engineering recognizes 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.

The Civil Engineering plan has four specializations recognized by the Faculty of Engineering:

- Geotechnical Specialization
- Structural Specialization
- Transportation Specialization
- Water Resources Specialization

Each specialization requires students to select technical electives with a common theme. Students are
responsible for meeting the TE requirements of the Civil Engineering degree when pursuing a specialization. Each specialization requires the successful completion of a minimum number of TEs specified by the specialization with an average of at least 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.

Geotechnical Specialization

The Geotechnical Specialization course requirements are:

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 414</td>
<td>Structural Concrete Design</td>
<td>S</td>
<td>A</td>
</tr>
<tr>
<td>CIVE 422</td>
<td>Finite Element Analysis or Finite Element Method</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>or ME 559</td>
<td></td>
<td>F,S</td>
<td></td>
</tr>
<tr>
<td>CIVE 542</td>
<td>Pavement Structural Design</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>EARTH 438</td>
<td>Engineering Geology</td>
<td>W</td>
<td>B</td>
</tr>
</tbody>
</table>

Structural Specialization

The Structural Specialization course requirements are:

1. At least five TEs from the list below.
2. At least one of CIVE 413 or CIVE 414 must be taken in the five TEs.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 306</td>
<td>Mechanics of Solids 3</td>
<td>F</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 413</td>
<td>Structural Steel Design</td>
<td>S</td>
<td>A</td>
</tr>
<tr>
<td>CIVE 414</td>
<td>Structural Concrete Design</td>
<td>S</td>
<td>A</td>
</tr>
<tr>
<td>CIVE 415</td>
<td>Structural System Design</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>CIVE 422</td>
<td>Finite Element Analysis</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 460</td>
<td>Engineering Biomechanics</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>CIVE 505</td>
<td>Structural Dynamics</td>
<td>S</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 507</td>
<td>Building Science and Technology</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 512</td>
<td>Rehabilitation of Structures</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>CIVE 596</td>
<td>Construction Engineering</td>
<td>S</td>
<td>A</td>
</tr>
</tbody>
</table>

Transportation Specialization
The Transportation Specialization course requirements are:

1. At least four TEs from the list below.
2. At least three of the four TEs must be CIVE courses.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 343</td>
<td>Traffic Simulation Modelling and Applications</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>CIVE 440</td>
<td>Transit Planning and Operations</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 484</td>
<td>Physical Infrastructure Planning</td>
<td>S</td>
<td>B</td>
</tr>
<tr>
<td>CIVE 542</td>
<td>Pavement Structural Design</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>GEOG 381</td>
<td>Advanced Geographic Information Systems</td>
<td>F,S</td>
<td>B</td>
</tr>
<tr>
<td>PLAN 416</td>
<td>Modelling the City</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>PLAN 477</td>
<td>Freight Planning and Policy</td>
<td>W</td>
<td>B</td>
</tr>
</tbody>
</table>

Water Resources Specialization

The Water Resources Specialization course requirements are:

1. ENVE 383 Advanced Hydrology and Hydraulics (W, TE List B).
2. At least three TEs from the list below.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 583</td>
<td>Design of Urban Water Systems</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>EARTH 444</td>
<td>Applied Wetland Science</td>
<td>F</td>
<td>B</td>
</tr>
<tr>
<td>EARTH 458</td>
<td>Physical Hydrogeology</td>
<td>F,S</td>
<td>B</td>
</tr>
<tr>
<td>ENVE 376</td>
<td>Biological Processes</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>ENVE 573</td>
<td>Contaminant Transport</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>GEOG 209</td>
<td>Hydroclimatology</td>
<td>W,S</td>
<td>B</td>
</tr>
<tr>
<td>GEOG 305</td>
<td>Fluvial Geomorphology</td>
<td>F</td>
<td>B</td>
</tr>
<tr>
<td>GEOG 371</td>
<td>Advanced Remote Sensing Techniques</td>
<td>F</td>
<td>B</td>
</tr>
<tr>
<td>GEOG 381</td>
<td>Advanced Geographic Information Systems</td>
<td>F,S</td>
<td>B</td>
</tr>
<tr>
<td>SYDE 533</td>
<td>Conflict Resolution</td>
<td>F</td>
<td>A</td>
</tr>
</tbody>
</table>

Faculty Options

The Faculty of Engineering recognizes options within the BASc degree. Students who satisfy the option requirements (courses and grades) will have the option designation shown on their transcript and diploma. Options are intended to recognize success in a field of study outside of the basic degree. Consequently, students must usually take extra courses to complete an option.

Options recently completed by students in Civil Engineering are the Entrepreneurship Option, Environmental Engineering Option, International Studies Option, Management Sciences Option, and Statistics Option. Complete details of designated options available to engineering students are provided in this Calendar in the section entitled Options, Specializations and Electives for Engineering.
Students. Students who satisfy the option requirements will have the appropriate designation shown on their transcript. The following three options are of primary interest to Civil Engineering students. (Note: To qualify for these options, the student must achieve a grade of at least 50% in each course and must obtain a cumulative average of at least 60% in these courses.)

Environmental Engineering Option

The Environmental Engineering Option is for students who wish to pursue their education with an emphasis on environmental concerns, assessment of the environmental impact of new or existing products or processes, methods for solving problems resulting from pollution in the air, in the water, or in the earth, and on the management of resources in order to minimize pollution in the environment. This is a Faculty option and includes course material related to all of the disciplines but applied specifically to environmental concerns.

Water Resources Option

The Water Resources Option is a designated Engineering Faculty Option available to Civil Engineering students interested in the development, management, and protection of our water resources. Students may choose from the water and waste management elective courses or the water resources engineering elective courses as well as from a list of approved courses from other departments. Students who complete the Option will have both a Water Resources and a Civil Engineering designation on their transcript.

Management Sciences Option

The Management Sciences Option provides an understanding of the issues, concepts, and techniques related to the management of technology and consists of a sequence of six courses. A student who wishes to follow the Management Sciences Option must declare their intent before starting the 2B term. For further details see the Engineering Management Sciences Option website.

Accelerated Master's Program in Engineering

The Faculty of Engineering offers an Accelerated Master's Program. See Accelerated Master's Programs in Engineering for details.
Environmental Engineering

Any civilization inevitably generates a waste stream. If not properly managed, this waste can lead to pollution of our water, soil, and air, which can endanger human life, harm ecosystems, and reduce our ability to thrive as a society. Environmental engineers are charged with managing these residuals of civilization. This responsibility includes cleaning up existing pollution from our water and soils, developing technological solutions to reduce the presence or risk of pollutants from future human activities, and providing a safe supply of water for domestic, industrial, and agricultural use.

Competency as an environmental engineer requires an understanding of the complex pathways through which pollutants can move, the chemistry of contaminants, the biology of microbes that can consume and transform them, and the various technological and societal solutions we can employ to clean our water, air, and soil and reduce the amount of pollutants emitted into the world. This work is necessarily interdisciplinary, and environmental engineers must learn how to work with planners, industry, environmental advocacy groups, government regulators, and others. They must develop competencies in a range of scientific fields, from chemistry to biology to renewable energy. They also require the basic quantitative proficiencies, judgment, and design skills expected of engineers in other specialties.

Environmental Engineering is uniquely designed to produce graduates who can respond to these needs. The curriculum introduces the best available practices into the planning, design, analysis, and operation of natural and engineered water systems, and the management of our air and earth resources. The environmental engineering curriculum strongly emphasizes water resource and water quality engineering, which deals with flood control, environmental issues in groundwater/surface waters, and the planning, management, design, and operation of water supply, treatment, and distribution systems. It also emphasizes environmental assessment, principles of water management and treatment, remediation of surface water, groundwater and soils, biotechnology, and contaminant transport. Students graduate with social awareness, a breadth of real-world experience, and well-developed numerical and communication skills which will suit them to many tasks.

The curriculum has much in common with Civil Engineering, addressing concepts of sustainability and civil infrastructure. The first year of both plans is virtually identical, allowing students to transfer between them. In later years, the Environmental Engineering curriculum emphasizes environmental assessment, principles of water management and treatment, remediation of surface water, groundwater and soils, biotechnology, and contaminant transport. Students graduate with social awareness, a breadth of real-world experience, and well-developed numerical and communication skills which will suit them to many tasks.

Areas of Study

The plan has three study areas: waste and water treatment; migration pathways of chemicals in the environment; and environmental assessment and modelling.

The Environmental Engineering plan covers diverse study areas such as environmental assessment and modelling, engineering hydrology, pollution treatment and control, and environmental energy systems.
Available Options

Management Sciences Option
Society, Technology and Values
Software Engineering Option
Water Resources Option

Administration

Managed by the Department of Civil and Environmental Engineering (CEE), Environmental Engineering is an interdisciplinary plan involving resources from the Faculties of Engineering, Science, and Environment. Students apply directly to Environmental Engineering.

Academic Curriculum

Legend

CSE is a Complementary Studies Elective course
TE is Technical Elective course

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 153 Earth Engineering
GENE 123 ENVE 123 Electrical Circuits and Instrumentation
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
Term 2B (Fall)

**ENVE 298 Seminar**
ERS 215 Environmental and Sustainability Assessment 1 (List A-Impact Courses CSE)

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**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

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**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**
One **TE 1 Approved** Technical Elective

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**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**
Three Technical Electives
One Complementary Studies Elective (CSE 2)
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
Three Technical Electives
One Complementary Studies Elective (CSE 3)

Electives

Each student is 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 are in part intended to 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 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

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), ERS 215 (List A), ENVE 392 (List B), and ENVE 391 (List D). The CSE courses are organized on a Faculty basis and detailed in this Calendar, on the Complementary Studies in the Faculty of Engineering page.

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:

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

Further information is available from the CEE Undergraduate Office or CEE website. 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 professor if the prerequisites have not been satisfied.

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 Key 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)**

<table>
<thead>
<tr>
<th>Term</th>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>F,W</td>
<td>CHE 361</td>
<td>Bioprocess Engineering</td>
</tr>
<tr>
<td>F,S</td>
<td>CHE 420</td>
<td>Introduction to Process Control</td>
</tr>
<tr>
<td>F</td>
<td>CIVE 241</td>
<td>Transport Principles and Applications</td>
</tr>
<tr>
<td>F</td>
<td>GEOE 354</td>
<td>Geotechnical Engineering 2</td>
</tr>
<tr>
<td>F</td>
<td>SYDE 533</td>
<td>Conflict Resolution</td>
</tr>
<tr>
<td>F</td>
<td>CHE 516</td>
<td>Energy Systems Engineering</td>
</tr>
<tr>
<td>F</td>
<td>CHE 571</td>
<td>Industrial Ecology</td>
</tr>
<tr>
<td>W</td>
<td>CHE 572</td>
<td>Air Pollution Control</td>
</tr>
<tr>
<td>W</td>
<td>CHE 574</td>
<td>Industrial Wastewater Pollution Control</td>
</tr>
<tr>
<td>W</td>
<td>CIVE 341</td>
<td>Transportation Engineering-Applications</td>
</tr>
<tr>
<td>W</td>
<td>CIVE 440</td>
<td>Transit Planning and Operations</td>
</tr>
<tr>
<td>W</td>
<td>ENVE 583</td>
<td>Design of Urban Water Systems</td>
</tr>
<tr>
<td>W</td>
<td>ENVE 577</td>
<td>Engineering for Solid Waste Management</td>
</tr>
<tr>
<td>W</td>
<td>GEOE 554</td>
<td>Geotechnical Engineering 3</td>
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<td>W</td>
<td>ME 571</td>
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<tr>
<td>W</td>
<td>SYDE 332</td>
<td>Introduction to Complex Systems</td>
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<tr>
<td>Course</td>
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<td>Term</td>
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<tr>
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</tr>
<tr>
<td>CHE 361</td>
<td>Bioprocess Engineering</td>
<td>F,W</td>
</tr>
<tr>
<td>CHE 420</td>
<td>Introduction to Process Control</td>
<td>F,S</td>
</tr>
<tr>
<td>CHE 514</td>
<td>Fundamentals of Petroleum Production</td>
<td>F</td>
</tr>
<tr>
<td>CHE 516</td>
<td>Energy Systems Engineering</td>
<td>F</td>
</tr>
<tr>
<td>CHE 571</td>
<td>Industrial Ecology</td>
<td>F</td>
</tr>
<tr>
<td>CHE 572</td>
<td>Air Pollution Control</td>
<td>W</td>
</tr>
<tr>
<td>CHE 574</td>
<td>Industrial Wastewater Pollution Control</td>
<td>W</td>
</tr>
<tr>
<td>CIVE 241</td>
<td>Transport Principles and Applications</td>
<td>F</td>
</tr>
<tr>
<td>CIVE 341</td>
<td>Transportation Engineering Applications</td>
<td>W</td>
</tr>
<tr>
<td>CIVE 495</td>
<td>Design Intensive Special Topics in Civil Engineering</td>
<td>as offered</td>
</tr>
<tr>
<td>EARTH 438</td>
<td>Engineering Geology</td>
<td>W</td>
</tr>
<tr>
<td>ENVE 495</td>
<td>Design Intensive Special Topics in Environmental Engineering</td>
<td>as offered</td>
</tr>
<tr>
<td>ENVE 577</td>
<td>Engineering for Solid Waste Management</td>
<td>W</td>
</tr>
<tr>
<td>ENVE 583</td>
<td>Design of Urban Water Systems</td>
<td>W</td>
</tr>
<tr>
<td>GEOE 354</td>
<td>Geotechnical Engineering 2</td>
<td>F</td>
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<tr>
<td>GEOE 554</td>
<td>Geotechnical Engineering 3</td>
<td>W</td>
</tr>
<tr>
<td>ME 452</td>
<td>Energy Transfer in Buildings</td>
<td>W</td>
</tr>
<tr>
<td>ME 571</td>
<td>Air Pollution</td>
<td>W</td>
</tr>
<tr>
<td>SYDE 532</td>
<td>Introduction to Complex Systems</td>
<td>W</td>
</tr>
<tr>
<td>SYDE 533</td>
<td>Conflict Resolution</td>
<td>F</td>
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<tr>
<td>SYDE 575</td>
<td>Image Processing</td>
<td>F</td>
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</tbody>
</table>

**TE List B - Technical Electives (choose a maximum of three)**

{table sorted by course; term offering on right; new entries: CIVE 507, EARTH 438, 444, 458, GEOE}
<table>
<thead>
<tr>
<th>Term</th>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>F,S</td>
<td>BIOL 354</td>
<td>Environmental Toxicology 1</td>
</tr>
<tr>
<td>F</td>
<td>BIOL 364</td>
<td>Mathematical Modelling in Biology</td>
</tr>
<tr>
<td>F</td>
<td>BIOL 447</td>
<td>Environmental Microbiology</td>
</tr>
<tr>
<td>F</td>
<td>BIOL 455</td>
<td>Ecological Risk Assessment and Management</td>
</tr>
<tr>
<td>F</td>
<td>BIOL 462</td>
<td>Applied Wetland Science</td>
</tr>
<tr>
<td>F</td>
<td>BIOL 470</td>
<td>Methods of Aquatic Ecology</td>
</tr>
<tr>
<td>F</td>
<td>CHE 514</td>
<td>Fundamentals of Petroleum Production</td>
</tr>
<tr>
<td>F,W,S</td>
<td>CHEM 237</td>
<td>Introductory Biochemistry</td>
</tr>
<tr>
<td>F,W</td>
<td>CHEM 262</td>
<td>Organic Chemistry for Engineering</td>
</tr>
<tr>
<td>F</td>
<td>EARTH 342</td>
<td>Geomorphology and GIS Applications</td>
</tr>
<tr>
<td>F</td>
<td>EARTH 421</td>
<td>Geochemistry 2</td>
</tr>
<tr>
<td>F</td>
<td>EARTH 440</td>
<td>Quaternary Geology</td>
</tr>
<tr>
<td>F</td>
<td>EARTH 444</td>
<td>Applied Wetland Science</td>
</tr>
<tr>
<td>F</td>
<td>GEOG 459</td>
<td>Energy and Sustainability</td>
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<tr>
<td>F,S</td>
<td>ME 459</td>
<td>Energy Conversion</td>
</tr>
<tr>
<td>F,S</td>
<td>ME 559</td>
<td>Finite Element Methods</td>
</tr>
<tr>
<td>F</td>
<td>SYDE 411</td>
<td>Optimization and Numerical Methods</td>
</tr>
<tr>
<td>F</td>
<td>SYDE 575</td>
<td>Image Processing</td>
</tr>
<tr>
<td>W</td>
<td>BIOL 488</td>
<td>Ecotoxicology from a Watershed Perspective</td>
</tr>
<tr>
<td>W</td>
<td>CIVE 422</td>
<td>Finite Element Analysis</td>
</tr>
<tr>
<td>W,S</td>
<td>CIVE 497</td>
<td>Special Topics in Civil Engineering (as offered)</td>
</tr>
<tr>
<td>W</td>
<td>EARTH 221</td>
<td>Geochemistry 1</td>
</tr>
<tr>
<td>W</td>
<td>EARTH 456</td>
<td>Numerical Methods in Hydrogeology</td>
</tr>
<tr>
<td>W</td>
<td>EARTH 459</td>
<td>Chemical Hydrogeology</td>
</tr>
<tr>
<td>W</td>
<td>ENVE 573</td>
<td>Contaminant Transport</td>
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<tr>
<td>W</td>
<td>GEOG 471</td>
<td>Remote Sensing Project</td>
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<tr>
<td>W</td>
<td>SYDE 531</td>
<td>Design Optimization Under Probabilistic Uncertainty</td>
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<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Term(s)</td>
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<tr>
<td>CIVE 422</td>
<td>Finite Element Analysis</td>
<td>W</td>
</tr>
<tr>
<td>CIVE 440</td>
<td>Transit Planning and Operations</td>
<td>W</td>
</tr>
<tr>
<td>CIVE 507</td>
<td>Building Science and Technology</td>
<td>W</td>
</tr>
<tr>
<td>EARTH 221</td>
<td>Geochemistry 1</td>
<td>W,S</td>
</tr>
<tr>
<td>EARTH 342</td>
<td>Geomorphology and GIS Applications</td>
<td>F</td>
</tr>
<tr>
<td>EARTH 421</td>
<td>Geochemistry 2</td>
<td>F</td>
</tr>
<tr>
<td>EARTH 439</td>
<td>Flow and Transport Through Fractured Rocks</td>
<td>W</td>
</tr>
<tr>
<td>EARTH 440</td>
<td>Quaternary Geology</td>
<td>F</td>
</tr>
<tr>
<td>EARTH 444</td>
<td>Applied Wetland Science</td>
<td>F</td>
</tr>
<tr>
<td>EARTH 456</td>
<td>Numerical Methods in Hydrogeology</td>
<td>W</td>
</tr>
<tr>
<td>EARTH 459</td>
<td>Chemical Hydrogeology</td>
<td>W</td>
</tr>
<tr>
<td>ENVE 497</td>
<td>Special Topics in Environmental Engineering as offered</td>
<td></td>
</tr>
<tr>
<td>ENVE 573</td>
<td>Contaminant Transport</td>
<td>W</td>
</tr>
<tr>
<td>GEOG 209</td>
<td>Hydroclimatology</td>
<td>W,S</td>
</tr>
<tr>
<td>GEOG 305</td>
<td>Fluvial Geomorphology</td>
<td>F</td>
</tr>
<tr>
<td>GEOG 371</td>
<td>Advanced Remote Sensing Technology</td>
<td>F</td>
</tr>
<tr>
<td>GEOG 381</td>
<td>Advanced Geographic Information Systems</td>
<td>F,S</td>
</tr>
<tr>
<td>GEOG 409</td>
<td>Energy Balance Climatology</td>
<td>W</td>
</tr>
<tr>
<td>GEOG 471</td>
<td>Remote Sensing Project</td>
<td>W</td>
</tr>
<tr>
<td>ME 354</td>
<td>Thermodynamics 2</td>
<td>W,S</td>
</tr>
<tr>
<td>ME 459</td>
<td>Energy Conversion</td>
<td>F,S</td>
</tr>
<tr>
<td>ME 559</td>
<td>Finite Element Methods</td>
<td>F,S</td>
</tr>
<tr>
<td>SYDE 411</td>
<td>Optimization and Numerical Methods</td>
<td>F</td>
</tr>
<tr>
<td>SYDE 531</td>
<td>Design Optimization Under Probabilistic Uncertainty</td>
<td>W</td>
</tr>
</tbody>
</table>

**Note on List B:**

Special topics courses (CIVE 497) are offered as resources and faculty interests permit. Students should consult the CEE Undergraduate Office or CEE website for upcoming topics.
**Complementary Studies Electives**

Two complementary studies elective (CSE) 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 392 (List B), and ENVE 391 (List D). The CSE courses are organized on a Faculty basis and detailed in this Calendar, on the Complementary Studies in the Faculty of Engineering page.

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

**Specializations**

The Faculty of Engineering recognizes 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.

The Environmental Engineering plan has three specializations recognized by the Faculty of Engineering:

- **Energy Specialization**
- **Hydrology Specialization**
- **Pollution Treatment and Control Specialization**

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 an average of at least 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.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 516</td>
<td>Energy Systems Engineering</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>CIVE 495</td>
<td>Design Intensive Special Topics in Civil Engineering Topic: Building Energy Analysis</td>
<td>F,S</td>
<td>A</td>
</tr>
</tbody>
</table>
## CIVE 495 Design Intensive Special Topics in Civil Engineering

**Topic: HVAC Energy Efficiency (Low-Energy Building System)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 507</td>
<td>Building Science and Technology</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>GEOG 409</td>
<td>Energy Balance Climatology</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>ME 354</td>
<td>Thermodynamics 2</td>
<td>W,S</td>
<td>B</td>
</tr>
<tr>
<td>ME 452</td>
<td>Energy Transfer in Buildings</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>ME 459</td>
<td>Energy Conversion</td>
<td>F,S</td>
<td>B</td>
</tr>
</tbody>
</table>

### Hydrology Specialization

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 470</td>
<td>Methods of Aquatic Ecology</td>
<td>F</td>
<td>B</td>
</tr>
<tr>
<td>EARTH 439</td>
<td>Flow and Transport Through Fractured Rocks</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>EARTH 444</td>
<td>Applied Wetland Science</td>
<td>F</td>
<td>B</td>
</tr>
<tr>
<td>EARTH 459</td>
<td>Chemical Hydrogeology</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>ENVE 573</td>
<td>Contaminant Transport</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>ENVE 583</td>
<td>Design of Urban Water Systems</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>GEOG 209</td>
<td>Hydroclimatology</td>
<td>W,S</td>
<td>B</td>
</tr>
<tr>
<td>GEOG 305</td>
<td>Fluvial Geomorphology</td>
<td>F</td>
<td>B</td>
</tr>
<tr>
<td>GEOG 371</td>
<td>Advanced Remote Sensing Techniques</td>
<td>F</td>
<td>B</td>
</tr>
<tr>
<td>GEOG 381</td>
<td>Advanced Geographic Information Systems</td>
<td>F,S</td>
<td>B</td>
</tr>
<tr>
<td>SYDE 532</td>
<td>Introduction to Complex Systems</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>SYDE 533</td>
<td>Conflict Resolution</td>
<td>F</td>
<td>A</td>
</tr>
</tbody>
</table>

### Pollution Treatment and Control Specialization

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHE 361</td>
<td>Bioprocess Engineering</td>
<td>F,W</td>
<td>A</td>
</tr>
<tr>
<td>CHE 420</td>
<td>Introduction to Process Control</td>
<td>F,S</td>
<td>A</td>
</tr>
<tr>
<td>CHE 571</td>
<td>Industrial Ecology</td>
<td>F</td>
<td>A</td>
</tr>
<tr>
<td>CHE 572</td>
<td>Air Pollution Control</td>
<td>W</td>
<td>A</td>
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<tr>
<td>CHE 574</td>
<td>Industrial Wastewater Pollution Control</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>ENVE 573</td>
<td>Contaminant Transport</td>
<td>W</td>
<td>B</td>
</tr>
<tr>
<td>ENVE 577</td>
<td>Engineering for Solid Waste Management</td>
<td>W</td>
<td>A</td>
</tr>
<tr>
<td>ME 571</td>
<td>Air Pollution</td>
<td>W</td>
<td>A</td>
</tr>
</tbody>
</table>
Faculty Options

The Faculty of Engineering recognizes options within the BASc degree. Students who satisfy the option requirements (courses and grades) will have the option designation shown on their transcript and diploma. Options are intended to recognize success in a field of study outside of the basic degree. Consequently, students must usually take extra courses to complete an option.

Options recently completed by students in Environmental Engineering are the Management Sciences Option, Physical Sciences Option, and Statistics Option. Complete details of designated options available to Engineering students are provided in this Calendar in the section entitled Options, Specializations and Electives for Engineering Students. Students who satisfy option requirements will have the designation on their transcript and degree. The following three options are of primary interest to Environmental Engineering students. (Note: To qualify for these options, the student must achieve a grade of at least 50% in each course and must obtain a cumulative average of at least 60% in these courses.)

Water Resources Option

The Water Resources Option is a designated Engineering Option available to Environmental Engineering students interested in the development, management, and protection of our water resources.

Management Sciences Option

The Management Sciences Option provides an understanding of the issues, concepts, and techniques related to the management of technology. A student who wishes to follow the Management Sciences Option must declare their intent before starting the 2B term. For further details, see the Engineering Management Sciences Option website.

Statistics Option

The Statistics Option provides a broad background in applied statistics, especially in the areas of multiple regression, quality control, experimental design, and applied probability.

Accelerated Master's Program in Engineering

The Faculty of Engineering offers an Accelerated Master's Program. See Accelerated Master's Programs in Engineering for more details.
Geological Engineering

The Geological Engineering curriculum at the University of Waterloo delivers a diverse set of core courses that provide the necessary fundamentals in mathematics, geology, and civil engineering. Geological Engineering also offers the opportunity to take electives from the fields of the social sciences and humanities. Technical electives can be chosen to develop a focus in the following areas.

**Geology**

*Studies the Earth, its structure and composition, and the physical, chemical, and biological processes that have affected and continue to shape this planet over a variety of time scales.*

*Enhanced training in geology leads to exploration for natural resources (minerals, oil, and gas), environmental protection, identifying geological hazards, and understanding global climate change.*

**Geophysics**

Develops technical skills for students to use instrumentation (seismic, electromagnetic, resistivity, gravity, etc.) in order to explore for minerals, as well as, oil and gas reservoirs. Strategies are also presented to adapt these techniques to groundwater resource evaluation and subsurface contaminant monitoring. Non-destructive methodologies are also presented to assess the physical state of infrastructure to optimize operation and maintenance activities.

**Geotechnical Engineering**

Familiarizes students with the engineering properties of soils and rocks, the fundamentals of soil and rock mechanics, and the application of geotechnical data and concepts to: the design of foundation elements, soil and rock retaining structures and excavations, as well as, the stability of soil and rock embankments and slopes. The specific focus is on the design, construction, and maintenance of infrastructure located on or below the earth's surface and geotechnical aspects of geohazards.

**Hydrogeology**

*Integrates geological knowledge with the principles of subsurface fluid flow, contaminant migration, geochemistry, mathematics, and physics in order to understand and protect groundwater resources. Applications of hydrogeology include the search for groundwater supplies, assessment and remediation of soil and groundwater contamination due to industrial, agricultural, and mining practices, and conducting watershed studies to assess environmental impacts due to urban and rural activities.*

**Water Resources Engineering**

*Deals with the planning, management, design, and operation of groundwater and surface water supply and distribution systems, flood control and flood hazard mapping, hydrologic and hydraulic aspects of*
environmental issues, and application of remotely-sensed data to hydrologic and environmental problems.

**Water and Waste Management Engineering**

Addresses water and waste water treatment, surface and ground water pollution and control, solid and hazardous waste management, contaminant transport and behaviour in the environment. Support areas involving aquatic chemistry, computer modelling, simulation and laboratory experimentation as examples are also stressed.

While the first three areas are shared with Civil Engineering, the fourth is not. The Geological Engineering curriculum is designed to enhance the students' knowledge in topics associated with earth processes. Hence, the Geological Engineering student will have a greater deep knowledge of details such as the mineralogical structure and associated mechanical and fluid conductance properties of various types of soils and rocks, as well as, their genesis and evolution due to mechanisms such as weathering, deposition and metamorphism, and weathering. These details enable the geological engineer to significantly expand upon and utilize the focused knowledge gained from these areas of focus in practice.

Canada has a global reach in geological engineering and professional job prospects upon graduation are excellent. Employment opportunities for geological engineers are available in the areas of petroleum geology and engineering, geohazard characterization and risk assessment (especially landslides), mining geology and mine design, foundations engineering and buried infrastructure, groundwater and surface water management, geophysics, coastal engineering and granular material supply. An increasing amount of activity lies in the geotechnical investigations associated with mine development, geomechanical aspects of petroleum recovery (both conventional and unconventional, such as tar sands development and in-situ heavy oil extraction), and in the field of landslide hazard assessment and remediation. Geotechnical expertise is also required in infrastructure projects, particularly in capital works and operation and maintenance activities associated with tunnels, roads, railways, buildings, airports, shorelines, underground storage, and waste disposal facilities. The geological engineer focusing in hydrogeology and subsurface fluid flow can become involved in environmental site evaluation, groundwater resource management and contaminated site restoration, as well as, geothermal and petroleum resource exploration and development.

**Academic Curriculum**

**Legend**

CSE is a Complementary Studies Elective course  
TE is a Technical Elective course  
+ This course 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 1A (Fall)**

[CHECK 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
GENE 123 GEOE 123 Electrical Circuits and Instrumentation
GEOE 121 Computational Methods
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 Applied Geophysics 1
GEOE 221 Advanced Calculus
GEOE 299 Seminar
WKRPT 200 Work-term Report
CSE 2 Approved Complementary Studies Elective

Term 3A (Spring)

EARTH 232 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 Electives List

{remove ARCH 277 due to CEE developing special topics course in timber, taught by new faculty members who are timber experts; service teaching cost; zero GEOEs enrolled in S19}
ARCH 277 Timber: Design, Structure and Construction for Engineers
CIVE 205 Solid Mechanics 2
EARTH 221 Geochemistry 1

Term 3B (Winter)

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

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 Electives 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 332 Metamorphic Petrology
EARTH 342 Geomorphology and GIS Applications
EARTH 421 Geochemistry 2
EARTH 440 Quaternary Geology
EARTH 444 Applied Wetland Science
EARTH 461 Applied Geophysics 3
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 Electives - List

CHE 514 Fundamentals of Petroleum Production
CIVE 303 Structural Analysis 1
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 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 Applied Geophysics 2
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

Notes

1. The availability of some elective courses is contingent upon sufficient demand, scheduling constraints, and teaching resources.
2. Each proposed plan of study should be reviewed by the faculty advisor to ensure that it (a) satisfies prescribed minimum requirements with respect to mathematics, science, engineering science, engineering design and complementary studies, and (b) satisfies prerequisite requirements.

Electives

Each student is 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 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 Elective

Three 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), GEOE 391 (List D), and GEOE 392 (List B). The CSE courses are organized on a Faculty basis and detailed in this Calendar, under the Complementary Studies in the Faculty of Engineering page. 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 elective (TE) courses 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, term of offering, or meet times 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 specializations with the Geological Engineering BASe 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.

The Geological Engineering plan has three specializations recognized by the Faculty of Engineering:

- Geology Specialization
- Hydrogeology Specialization
- Soil, Rock and Structures Specialization

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 an average of at least 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:

1. EARTH 221 Geochemistry 1 (3A TE) and EARTH 471 Mineral Deposits (4B TE)
2. At least two TEs from the list below.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
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<tr>
<td>EARTH 331</td>
<td>Volcanology and Igneous Petrology</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>EARTH 332</td>
<td>Metamorphic Petrology</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>EARTH 342</td>
<td>Geomorphology and GIS Applications</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>EARTH 421</td>
<td>Geochemistry 2</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>EARTH 435</td>
<td>Advanced Structural Geology</td>
<td>W</td>
<td>4B</td>
</tr>
</tbody>
</table>

Hydrogeology Specialization

The Hydrogeology Specialization course requirements are:

1. EARTH 221 Geochemistry 1 (3A TE)
2. At least three TEs from the list below.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARTH 342</td>
<td>Geomorphology and GIS Applications</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>EARTH 421</td>
<td>Geochemistry 2</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>EARTH 439</td>
<td>Flow and Transport Through Fractured Rocks</td>
<td>W</td>
<td>4B</td>
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<tr>
<td>EARTH 440</td>
<td>Quaternary Geology</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>EARTH 444</td>
<td>Applied Wetland Science</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>EARTH 456</td>
<td>Numerical Methods in Hydrogeology</td>
<td>W</td>
<td>4B</td>
</tr>
<tr>
<td>EARTH 459</td>
<td>Chemical Hydrogeology</td>
<td>W</td>
<td>4B</td>
</tr>
<tr>
<td>EARTH 460</td>
<td>Applied Geophysics 2</td>
<td>W</td>
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<tr>
<td>EARTH 461</td>
<td>Applied Geophysics 3</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>ENVE 383</td>
<td>Advanced Hydrology and Hydraulics</td>
<td>W</td>
<td>4B</td>
</tr>
</tbody>
</table>

Soil, Rock and Structures Specialization

The Soil, Rock and Structures Specialization course requirements are:

1. CIVE 205 Solid Mechanics 2 (3A TE)
2. At least three TEs from the list below.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Term</th>
<th>TE List</th>
</tr>
</thead>
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<td>4B</td>
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<tr>
<td>CIVE 306</td>
<td>Mechanics of Solids 3</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>CIVE 310</td>
<td>Introduction to Structural Design</td>
<td>F</td>
<td>4A</td>
</tr>
<tr>
<td>CIVE 422</td>
<td>Finite Element Analysis or</td>
<td>W</td>
<td>4B</td>
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<tr>
<td>or</td>
<td>Finite Element Methods</td>
<td>F,S</td>
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<td>ME 559</td>
<td>Pavement Structural Design</td>
<td>W</td>
<td>4B</td>
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<td>CIVE 542</td>
<td>Advanced Structural Geology</td>
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<tr>
<td>EARTH 435</td>
<td>Advanced Structural Geology</td>
<td>W</td>
<td>4B</td>
</tr>
</tbody>
</table>

Faculty Options

The Faculty of Engineering recognizes options within the BASc degree. Students who satisfy the option requirements (courses and grades) will have the option designation shown on their transcript and diploma. Options are intended to recognize success in a field of study outside of the basic
degree. Consequently, students must usually take extra courses to complete an option.

Options recently completed by students in Geological Engineering are the Environmental Engineering Option, Management Sciences Option, and Physical Sciences Option. Complete details of designated options available to engineering students are provided in this Calendar in the section entitled Options, Specializations and Electives for Engineering Students. Students who satisfy option requirements will have the designation on their transcript and diploma. Three of the available options of specific interest to students in Geological Engineering are briefly summarized below.

**Management Sciences Option**

The Management Sciences Option provides an understanding of the issues, concepts, and techniques related to the management of technology. The Option consists of a sequence of six courses. A student who wishes to follow the Management Sciences Option must declare their intent before starting the 2B term. For further details see the Engineering Management Sciences Option website.

**International Studies in Engineering Option**

With the increasing emphasis on globalization of resource and environmental management, geological engineers are becoming actively involved in international projects overseas. The International Studies in Engineering Option will provide the student with the opportunity to enrich their education through language and cultural studies, and will also involve work experience in an international setting.

**Water Resources Option**

Students in Geological Engineering may choose to expand their studies to include a broader range of topics in water resource management. The Water Resources Option provides a combined emphasis on surface water and groundwater resources in both technical and social issues.

**Accelerated Master’s Program in Engineering**

The Faculty of Engineering offers an Accelerated Master’s Program. See Accelerated Master’s Programs section for details.
Computer Engineering and Electrical Engineering

The fields of computer engineering and electrical engineering have co-evolved over the past several decades into an exciting interwoven tapestry of 10 thematic subdisciplines, all sharing common foundations from science, mathematics, and computing. Students in either plan of study share foundations and a portion of each theme to gain the breadth and depth of understanding necessary for lifelong learning in any area of computer or electrical engineering.

The Computer Engineering and the Electrical Engineering plans start out pre-structured to span the 10 themes in slightly different ways while still allowing flexibility for students to choose the full depth of study in any subdiscipline or to switch between the two plans. Within the specified framework of study, students make, according to their developing interests, choices to define their technical focus, choices regarding how they enhance their science background, and choices to expand their non-technical knowledge or skills. The goal is to graduate students with solid core engineering competencies but highly customizable depth, breadth, and focus. They are employed in an extremely varied set of occupations, essentially any place where there is design activity involving electricity, electronics, computers, or software.

The Department of Electrical and Computer Engineering (ECE), which administers the Computer Engineering and the Electrical Engineering plans, is itself a richly diverse unit and is a partner in offering four other interdisciplinary undergraduate plans, namely Biomedical Engineering, Mechatronics Engineering, Nanotechnology Engineering, and Software Engineering.

The following thematic subdisciplines are covered in varying degrees by the two plans.

1. Communications, modulation and coding, multimedia, and wireless systems.
2. Networks and mobile/distributed computing.
3. Energy distribution, motors/generators, power electronics, and energy marketing.
4. Control, automation, robotics, and mechatronics.
5. Computer architecture, embedded computers, and formal specification and design.
7. Microwave (radio frequency) and photonic devices and systems.
8. Signal processing, computational intelligence, and soft computing.
10. Software engineering, requirements specification, software architectures, and verification.

Common elements of mathematics, science, and computing permeate these areas and tie them together with a concentration on engineering science (analysis) and engineering design (synthesis). Computer Engineering puts relatively more emphasis on digital hardware, embedded systems, software systems, and networks. Electrical Engineering puts relatively more emphasis on microwave/photonic systems, devices/fabrication, microelectronic circuits, and power. Because of commonalities between core offerings in either plan, it is relatively easy to transfer from one to the other, especially during the first three terms of study.

The curricula have elective choices in a wide array of non-technical fields, in technical areas both inside and outside of ECE, and in science. Engineered systems based on electronics or embedded computers are especially pervasive across most areas of society and it is increasingly important for students to be able to integrate their technical abilities with complementary skills. Teamwork and interdisciplinary collaboration are important aspects of the plans. The curricula places a significant emphasis on communication skills, design, and engineering professionalism. Broad-minded and deeply-trained students of computer or electrical engineering will make important contributions over the next several decades as the world addresses potential issues such as environmental quality, energy supply, better health care, etc.

The ECE Department houses committees and staff supporting curriculum development, plan operation, and student advisement. Help and information are available by contacting the ECE Undergraduate Office or browsing the ECE website.

Academic Curricula

The curricula involve 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 ECE Undergraduate Office is required for all changes from the specified plans. 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 the Co-operative Education System apply, as further described in the Engineering Work Terms section 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, in either Computer Engineering or Electrical Engineering, are described in the Engineering Examinations and Promotions section of this Calendar. These include term-average requirements, course-grade requirements, and milestone requirements.

Notes

1. Milestones have deadlines for successful completion and are shown in the terms 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) as per Rule 11 of the Examinations and Promotions Rules. 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 plan-specific 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 20 and PD 21, 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 plan-specific list. These courses cannot be dropped for a reduced-load term.

5. In their 4A/4B terms, students must enrol in the ECE 498A/ECE 498B sequence or the GENE 403/GENE 404 sequence. ECE 498A/GENE 404 and ECE 498B/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.

Legend for the tables below

The tables below outline the contents of the eight academic terms and six co-operative work terms. The ordering of the terms is as described in the Study/Work Sequence Engineering section. The superscripts 8 and 4F are for information specific to Stream "8" and Stream "4F", respectively. For academic terms, the average scheduled hours per week are indicated in the columns Cls for class (LEC or SEM), Tut for tutorial (TUT), and Lab for laboratory (LAB or PRJ). Most laboratories are either open or scheduled every second or third week. Further details on electives and milestones are provided below.

### Academic Plans

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<tr>
<th>Term</th>
<th>CE or EE</th>
<th>Course/Milestone</th>
<th>Title and Notes</th>
<th>Cls</th>
<th>Tut</th>
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<td>ECE 101B</td>
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<tr>
<td>EE ECE 209</td>
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<table>
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<tr>
<th>Term</th>
<th>Course Code</th>
<th>Course Name</th>
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<td>ECE 101D</td>
<td>Work-term Reflections (see note 1)</td>
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<td></td>
<td>ECE 101C</td>
<td>Work-term Reflections (see note 1)</td>
<td>3</td>
<td></td>
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<tr>
<td></td>
<td>ECE 301</td>
<td>Information Session</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>ECE 318</td>
<td>Communication Systems 1</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 327</td>
<td>Digital Hardware Systems</td>
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<td>ECE 350</td>
<td>Real-Time Operating Systems</td>
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<td>1.25</td>
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<tr>
<td></td>
<td>ECE 340</td>
<td>Electronic Circuits 2</td>
<td>3</td>
<td>1.25</td>
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<tr>
<td></td>
<td>ECE 375</td>
<td>Electromagnetic Fields and Waves</td>
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<td></td>
<td>ECE 380</td>
<td>Analog Control Systems</td>
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<td></td>
<td>One CSE, NSE, or TE (see note 2)</td>
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<td>ECE 318</td>
<td>Communication Systems 1</td>
<td>3</td>
<td>1.25</td>
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<tr>
<td></td>
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<td></td>
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<td>Computer Architecture</td>
<td>3</td>
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<tr>
<td></td>
<td>ECE 351</td>
<td>Compilers</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 356</td>
<td>Database Systems</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 358</td>
<td>Computer Networks</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>EE</td>
<td>Choose two of the following four courses (see note 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ECE 313</td>
<td>Digital Signal Processing</td>
<td>3</td>
<td>1.25</td>
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<tr>
<td></td>
<td>ECE 331</td>
<td>Electronic Devices</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 360</td>
<td>Power-Systems and Smart Grids</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 373</td>
<td>Radio Frequency and Microwave Circuits</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>Choose one of the remaining six courses from ECE 313, ECE 320, ECE 331, ECE 351, ECE 356, ECE 358, ECE 360, ECE 373 provided prerequisites are met and subject to scheduling constraints</td>
<td></td>
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<tr>
<td></td>
<td>One CSE, NSE, or TE (see note 2)</td>
<td></td>
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<tr>
<td>Work Term Winter</td>
<td>COOP 4</td>
<td>Co-operative Work Term</td>
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<td></td>
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<td></td>
<td>One Professional Development Elective (see note 3)</td>
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<tr>
<td>Academic Term 3B</td>
<td>ECE 101D</td>
<td>Work-term Reflections (see note 1)</td>
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<td>ECE 302</td>
<td>Information Session</td>
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<td></td>
<td>ECE 307</td>
<td>Probability Theory and Statistics 2</td>
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<td></td>
<td>One CSE, NSE, or TE (see note 2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CE</td>
<td>Choose two of the following four courses (see note 4):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ECE 320</td>
<td>Computer Architecture</td>
<td>3</td>
<td>1.25</td>
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<tr>
<td></td>
<td>ECE 351</td>
<td>Compilers</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 356</td>
<td>Database Systems</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 358</td>
<td>Computer Networks</td>
<td>3</td>
<td>1.25</td>
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<tr>
<td></td>
<td>EE</td>
<td>Choose two of the following four courses (see note 4)</td>
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<td></td>
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<tr>
<td></td>
<td>ECE 313</td>
<td>Digital Signal Processing</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 331</td>
<td>Electronic Devices</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 360</td>
<td>Power-Systems and Smart Grids</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>ECE 373</td>
<td>Radio Frequency and Microwave Circuits</td>
<td>3</td>
<td>1.25</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>Choose one of the remaining six courses from ECE 313, ECE 320, ECE 331, ECE 351, ECE 356, ECE 358, ECE 360, ECE 373 provided prerequisites are met and subject to scheduling constraints</td>
<td></td>
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<td></td>
<td>Four elective courses, CSE, NSE, or TE, as necessary (see note 2)</td>
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<td>Work Term Fall</td>
<td>COOP 6</td>
<td>Co-operative Work Term</td>
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<td></td>
<td>One Professional Development Elective (see note 3)</td>
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<td>ECE 402</td>
<td>Information Session</td>
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<tr>
<td></td>
<td>One Professional Development Elective (see note 3)</td>
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</table>
Work-term Reflections

For each of the Work-term Reflections (ECE 101) courses, 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 CR/NCR.

Elective Courses

Complementary Studies Electives

Students must complete three complementary studies elective (CSE) courses 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, ENGL 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

In addition to the core technical courses, students must understand and be able to apply the Engineering Code of Ethics. To meet this 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 elective (NSE) courses, and are responsible for ensuring they meet the minimum Academic Units (AUs) using the AU calculator provided. The two NSE courses must be primarily concerned with natural science and are in addition to the science components of the core curricula, such as ECE 105, ECE 106, and ECE 109.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>BIOL 110</td>
<td>Introductory Zoology</td>
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<tr>
<td>BIOL 130 and BIOL 130L</td>
<td>Introductory Cell Biology/Cell Biology Laboratory</td>
</tr>
<tr>
<td>BIOL 150</td>
<td>Organismal and Evolutionary Ecology</td>
</tr>
<tr>
<td>BIOL 165</td>
<td>Diversity of Life</td>
</tr>
<tr>
<td>BIOL 211</td>
<td>Introductory Vertebrate Zoology</td>
</tr>
<tr>
<td>BIOL 240 and BIOL 240L</td>
<td>Fundamentals of Microbiology/Microbiology Laboratory</td>
</tr>
</tbody>
</table>
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 academic plans above.

2. At least three TEs must be courses chosen from ECE 406-ECE 493 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 Computer or Electrical 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 or 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 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. 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.

6. 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.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 414</td>
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<td>3</td>
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<tr>
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<td>Image Processing</td>
<td>3</td>
<td>1</td>
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<tr>
<td>ECE 418</td>
<td>Communications Networks</td>
<td>3</td>
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<td>0</td>
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<td>ECE 432</td>
<td>Radio Frequency Integrated Devices and Circuits</td>
<td>3</td>
<td>1</td>
<td>1.5</td>
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<tr>
<td>ECE 445</td>
<td>Integrated Digital Electronics</td>
<td>3</td>
<td>1</td>
<td>1.5</td>
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<tr>
<td>ECE 452</td>
<td>Software Design and Architectures</td>
<td>3</td>
<td>1</td>
<td>1.5</td>
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<tr>
<td>ECE 454</td>
<td>Distributed Computing</td>
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<td>1.5</td>
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<tr>
<td>ECE 455</td>
<td>Embedded Software</td>
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<td>1</td>
<td>1.5</td>
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<tr>
<td>ECE 457A</td>
<td>Cooperative and Adaptive Algorithms</td>
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<td>ECE 458</td>
<td>Computer Security</td>
<td>3</td>
<td>1</td>
<td>1.5</td>
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<tr>
<td>ECE 462</td>
<td>Electrical Distribution Systems</td>
<td>3</td>
<td>1</td>
<td>1.5</td>
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<tr>
<td>ECE 463</td>
<td>Design &amp; Applications of Power-Electronic Converters</td>
<td>3</td>
<td>1</td>
<td>1.5</td>
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<tr>
<td>ECE 475</td>
<td>Radio-Wave Systems</td>
<td>3</td>
<td>1</td>
<td>1.5</td>
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<td>ECE 481</td>
<td>Digital Control Systems</td>
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<td>ECE 486</td>
<td>Robot Dynamics and Control</td>
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<td>ECE 493</td>
<td>Special Topics in Electrical and Computer Engineering (see note 7)</td>
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The following TE courses are normally offered for the winter (4B) term. The list is subject to change from year to year.

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<tr>
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<th>Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 406</td>
<td>Algorithm Design and Analysis</td>
<td>3</td>
<td>1</td>
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<tr>
<td>ECE 409</td>
<td>Cryptography and System Security</td>
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<tr>
<td>ECE 415</td>
<td>Multimedia Communications</td>
<td>3</td>
<td>1</td>
<td>1.5</td>
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</tbody>
</table>
The following project elective is offered every term. Students may take it, at most, once as a TE course.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 499</td>
<td>Engineering Project</td>
</tr>
</tbody>
</table>

Workplace Hazardous Materials Information System (WHMIS)

Under both the federal and provincial legislation, 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.

Available Options

The curricula in Computer Engineering and Electrical Engineering are designed to offer a well-balanced and rewarding education. Students wishing to further enrich their studies may take any option, minor, or joint degree for which they meet the eligibility requirements (see the section on Engineering Interdisciplinary Alternatives). Options typically require extra courses and/or constrain the choice of elective courses. When taking courses from a different plan, the student may need to do extra work to compensate for a different background preparation. Time beyond the normal plan duration may be necessary due to the extra requirements and constraints on space or scheduling.

Communications and Signal Processing Specialization

We take for granted remote connection to complex services, which may involve high-quality video streaming, human-machine voice interaction, biometric monitoring, image or video understanding, and rapidly evolving forms of assistance using artificial intelligence. Indeed, many are possible from a cell phone barrelling down a highway or embedded on a massive scale in sensor networks. They hold promise of meaningful impact on global problems such as aging and health care, education, social cohesion, resource and environmental management, crime prevention, and countless applications yet to be imagined. Beyond applying known algorithms, engineers need to understand fundamental principles from communications and signal processing, which are at the heart of sophisticated and powerful trade-offs in design. This specialization allows students to choose that depth
of learning within various combinations of its two core topics.

**Requirements**

Students interested in pursuing this specialization must achieve an average of at least 60% in the specialization courses, and a grade of at least 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 1

**Any three courses from the following list**

- ECE 358 Computer Networks  
- ECE 414 Communication Systems 2  
- ECE 415 Multimedia Communications  
- ECE 416 Advanced Topics in Networking  
- ECE 417 Image Processing  
- ECE 474 Radio and Wireless Systems

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**Computer Engineering**

The field of Computer Engineering shares foundations from science, mathematics, and computing. Students gain the breadth and depth of understanding necessary for lifelong learning in any area of Computer Engineering.

The Computer Engineering plan starts out pre-structured and shares a common 1A, 1B and 2A terms with Electrical Engineering. As students progress through the curriculum, and develop their interests, the plan provides students with choices that can further define their technical focus. The goal is to graduate students with solid core engineering competencies but highly customizable depth, breadth, and focus.

**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 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 the Co-operative Education System apply, as further described in the Engineering Work Terms section 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.

Notes

1. Milestones have deadlines for successful completion and are shown in the terms 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) as per Rule 11 of the Examinations and Promotions Rules. 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/4B terms, students must enrol in the ECE 498A/ECE 498B sequence or the GENE 403/GENE 404 sequence. ECE 498A/GENE 404 and ECE 498B/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.

Legend for the tables below

The tables below outline the contents of the eight academic terms and six co-operative work terms. The ordering of the terms is as described in the Study/Work Sequence section. A student is assigned to one of the two Streams: 8 or 4F. The superscripts 8 and 4F are for information specific to Stream "8" and Stream "4F", respectively. For academic terms, the average scheduled hours per week are indicated in the columns CIs for class (LEC or SEM), Tut for tutorial (TUT), and Lab for laboratory (LAB or PRJ). Most laboratories are either open or scheduled every second or third week. Further details on electives and milestones are provided below.
<table>
<thead>
<tr>
<th>Term</th>
<th>Course or Milestone</th>
<th>Title and Notes</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
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<td>PD 20</td>
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<td>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.</td>
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<td>ECE 498A/GENE 403</td>
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<td>Four elective courses, CSE, NSE, or TE, as necessary (see note 2)</td>
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<td>Four elective courses, CSE, NSE, or TE, as necessary (see note 2)</td>
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</table>
Work-term Reflections

For each of the Work-term Reflections (ECE 101) courses, 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 CR/NCR.

Elective Courses

Complementary Studies Electives

Students must complete three complementary studies elective (CSE) courses 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

In addition to the core technical courses, students must understand and be able to apply the Engineering ethics. To meet this 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 elective (NSE) courses, and are responsible for ensuring they meet the minimum Academic Units (AUs). 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.

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<td>BIOL 150</td>
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<td>BIOL 165</td>
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<td>BIOL 211</td>
<td>Introductory Vertebrate Zoology</td>
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<td>BIOL 240 and BIOL 240L</td>
<td>Fundamentals of Microbiology/Microbiology Laboratory</td>
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<td>BIOL 241</td>
<td>Introduction to Applied Microbiology</td>
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<td>BIOL 273</td>
<td>Principles of Human Physiology 1</td>
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<td>BIOL 373 and BIOL 373L</td>
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<td>Condensed Matter Physics</td>
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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 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.

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<th>Course</th>
<th>Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 414</td>
<td>Communication Systems 2</td>
<td>3</td>
<td>1</td>
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<tr>
<td>ECE 417</td>
<td>Image Processing</td>
<td>3</td>
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<tr>
<td>ECE 433</td>
<td>Fabrication Technologies for Micro and Nano Devices</td>
<td>3</td>
<td>1</td>
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</tr>
<tr>
<td>ECE 444</td>
<td>Integrated Analog Electronics</td>
<td>3</td>
<td>1</td>
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<tr>
<td>ECE 445</td>
<td>Integrated Digital Electronics</td>
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<td>1.25</td>
</tr>
<tr>
<td>ECE 452</td>
<td>Software Design and Architectures</td>
<td>3</td>
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<td>1.25</td>
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<tr>
<td>ECE 454</td>
<td>Distributed Computing</td>
<td>3</td>
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<tr>
<td>ECE 455</td>
<td>Embedded Software</td>
<td>3</td>
<td>1</td>
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<tr>
<td>ECE 457A</td>
<td>Cooperative and Adaptive Algorithms</td>
<td>3</td>
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</tr>
<tr>
<td>ECE 458</td>
<td>Computer Security</td>
<td>3</td>
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<tr>
<td>ECE 462</td>
<td>Electrical Distribution Systems</td>
<td>3</td>
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</table>
The following TE courses are normally offered for the winter (4B) term. The list is subject to change from year to year.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
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<tr>
<td>ECE 406</td>
<td>Algorithm Design and Analysis</td>
<td>3</td>
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<td>ECE 409</td>
<td>Cryptography and System Security</td>
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<tr>
<td>ECE 416</td>
<td>Advanced Topics in Networking</td>
<td>3</td>
<td>1</td>
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<tr>
<td>ECE 423</td>
<td>Embedded Computer Systems</td>
<td>3</td>
<td>1</td>
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<tr>
<td>ECE 432</td>
<td>Radio Frequency Integrated Devices and Circuits</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
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<tr>
<td>ECE 451</td>
<td>Software Requirements Specification and Analysis</td>
<td>3</td>
<td>1</td>
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<tr>
<td>ECE 453</td>
<td>Software Testing, Quality Assurance and Maintenance</td>
<td>3</td>
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<td>ECE 457B</td>
<td>Fundamentals of Computational Intelligence</td>
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<td>ECE 459</td>
<td>Programming for Performance</td>
<td>3</td>
<td>1</td>
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<td>ECE 464</td>
<td>High Voltage Engineering and Power System Protection</td>
<td>3</td>
<td>1</td>
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<td>ECE 467</td>
<td>Power Systems Analysis, Operations and Markets</td>
<td>3</td>
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<td>ECE 474</td>
<td>Radio and Wireless Systems</td>
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<td>ECE 477</td>
<td>Photonic Devices and Systems</td>
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<td>ECE 488</td>
<td>Multivariable Control Systems</td>
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<tr>
<td>ECE 493</td>
<td>Special Topics in Electrical and Computer Engineering (see note 7)</td>
<td>3</td>
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<tr>
<td>ECE 495</td>
<td>Autonomous Vehicle</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
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</table>

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
</tr>
</thead>
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<tr>
<td>ECE 499</td>
<td>Engineering Project</td>
<td>0</td>
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<td>10</td>
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</tbody>
</table>

**Workplace Hazardous Materials Information System (WHMIS)**

Under both the federal and provincial legislation, 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.

Available Options

The curriculum in Computer Engineering is designed to offer a well-balanced and rewarding education. Students wishing to further enrich their studies may take any option, minor, or joint degree for which they meet the eligibility requirements (see the section on Engineering Interdisciplinary Alternatives). Options typically require extra courses and/or constrain the choice of elective courses. When taking courses from a different plan, the student may need to do extra work to compensate for a different background preparation. Time beyond the normal plan duration may be necessary due to the extra requirements and constraints on space or scheduling.

Communications and Signal Processing Specialization

We take for granted remote connection to complex services, which may involve high-quality video streaming, human-machine voice interaction, biometric monitoring, image or video understanding, and rapidly evolving forms of assistance using artificial intelligence. Indeed, many are possible from a cell phone barrelling down a highway or embedded on a massive scale in sensor networks. They hold promise of meaningful impact on global problems such as aging and health care, education, social cohesion, resource and environmental management, crime prevention, and countless applications yet to be imagined. Beyond applying known algorithms, engineers need to understand fundamental principles from communications and signal processing which are at the heart of sophisticated and powerful trade-offs in design. This specialization allows students to choose that depth of learning within various combinations of its two core topics.

Requirements

Students interested in pursuing this specialization must achieve an average of at least 60% in the specialization courses, and a grade of at least 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 1

Any three courses from the following list

ECE 358 Computer Networks  
ECE 414 Communication Systems 2  
ECE 416 Advanced Topics in Networking  
ECE 417 Image Processing  
ECE 474 Radio and Wireless Systems
NEW COURSES  (for approval)

Electrical & Computer Engineering

Effective  01-SEP-2020
ECE  198  (0.25)  LAB  Project Studio
A design project integrating content from physics, math, and programming courses. Topics include engineering design process, problem definition, risk analysis, design specification, system modelling and analysis, engineering data analysis, project management, and prototyping. Students work in teams to build and test a prototype.

[Offered: F]

Requisites : Prereq: Level 1A Computer Engineering or Electrical Engineering
Rationale : A new course to provide students with experiential learning opportunities (no final exam).

Effective  01-SEP-2020
ECE  231  (0.50)  LAB, LEC, TUT  Semiconductor Physics and Devices
Introduction to the physical principles and electrical behavior of semiconductor materials and devices; electronic band structure, charge carriers, doping, carrier transport, pn-junctions, metal-oxide-semiconductor capacitors, transistors, and bipolar junction devices. [Offered: F,S]

Requisites : Prereq: ECE 106, 109; Level at least 2B Computer Engineering or Electrical Engineering
Rationale : This new course is a redesign of ECE 209 with new content and builds continuity with the third-year course.

Effective  01-SEP-2020
ECE  495  (0.50)  LAB, LEC, TUT  Autonomous Vehicles
Autonomous driving system overview; computer vision basics, deep learning for perception, motion modelling and state estimation, localization and mapping, object tracking, behavioral planning and reinforcement learning, path planning and vehicle control, safety and verification and validation, adoption and impact. [Offered: W]

Requisites : Prereq: Level at least 3B Computer Engineering or Electrical Engineering. Antireq: ME 597
Rationale : This new technical elective course is created from a topic in the Special Topics course (ECE 493), due to high demand.

COURSE CHANGES  (for approval)
Current Catalog Information

ECE 108 (0.50) LEC, PRJ, TUT  Discrete Mathematics and Logic I

Introduction to discrete mathematics, including propositional/Boolean logic, syntax and semantics, proof theory, and model theory; set theory, relations and functions, combinatorics (counting techniques, permutations, and combinations), graph theory. Applications in electrical, computing, and software engineering. [Offered: W, S]

No Special Consent Required

Requisites:
- Prereq: ECE 150, MATH 117; Level at least 1B Computer Engineering or Electrical Engineering or Software Engineering.
- Antireq: ECE 103, 155, MATH 229, 239, 249

Effective 01-SEP-2020

Component Change: LEC, TUT

Rationale: The project component is removed to reflect current teaching practice.

Current Catalog Information

ECE 190 (0.25) LEC  Engineering Profession and Practice

Introduction to electrical and computer engineering with an emphasis on the profession of engineering, and engineering design. Topics include engineering design, safety, risk analysis, engineering data analysis, project management, sustainability, business, entrepreneurship, and intellectual property. Additional topics include co-op fundamentals for engineering students, professional development, and diversity training with a goal of understanding the roles and responsibilities of the professional engineer in society. [Offered: F]

No Special Consent Required

Requisites:
- Prereq: Level at least 1A Computer Engineering or Electrical Engineering.
- Antireq: ECE 100A

Effective 01-SEP-2020

Unit Change: (0.50)

Component Change: LEC

Title Change: Engineering Profession and Practice, Technical Communications

Description Change: Fundamental knowledge and skills essential for academic and professional development in electrical and computer engineering. Topics include engineering professionalism, ethics, learning strategies, business/entrepreneurship, intellectual property, sustainability, fundamentals of oral and written technical communication, co-op fundamentals for engineering students, professional and academic development, and diversity training with a goal of understanding the roles and responsibilities of the professional engineer in society. Written, graphical, and oral communications are emphasized. [Offered: F]

Rationale: Communication topics are added to the title and description, the weight is increased from 0.25 to 0.50, and the LEC component contact hours increases from 2 to 3 hours. These changes will improve the student experience. One single course for ECE students resulting in a more uniform delivery of material across different sections. Integration of topics into a single
concepts and practice course facilitates the use of more examples drawn from electrical and computer engineering.

**Current Catalog Information**

**ECE 204 (0.50) LEC, TUT**  
**Numerical Methods**  
No Special Consent Required  
**Requisites:** Prereq: Level at least 2A Computer Engineering or Electrical Engineering.  
Antireq: AMATH 342, CS 370, 371, ECE 204A, 204B, MTE 204  
**Effective 01-SEP-2020**  
**Component Change:** LAB, LEC, TUT  
**Rationale:** Addition of a LAB component to provide students with MatLab experience.

**Current Catalog Information**

**ECE 404 (0.50) LEC, TUT**  
**Geometrical and Physical Optics**  
No Special Consent Required  
**Requisites:** Prereq: (One of PHYS 112, 122) or (ECE 105, 106); (One of MATH 108, 119, 128, 138, 148). Antireq: PHYS 226, 246, 256  
**Effective 01-SEP-2020**  
**Description Change:** Electromagnetic waves and the nature of light. Geometrical optics, aberrations. Physical Optics: interference, Fraunhofer and Fresnel diffraction, polarization. Optical instruments. [Offered: S]  
**Rationale:** The term offering is updated to help balance the elective choices for students.

**Current Catalog Information**

**ECE 409 (0.50) LEC, TUT**  
**Cryptography and System Security**  
Introduction to cryptology and computer security, theory of secure communications, points of attack, conventional cryptographic systems, public key cryptographic systems, standards, firewalls, wireless system security, applications. [Offered: W]  
No Special Consent Required  
**Requisites:** Prereq: ECE 358; Level at least 4A Computer Engineering or Electrical Engineering or Software Engineering. Antireq: CO 485, 487, CS 458  
**Effective 01-SEP-2020**  
**Requisite Change:** Prereq: ECE 358; Level at least 4A Computer Engineering or Electrical Engineering or Software Engineering. Antireq: CO 487, CS 458  
**Rationale:** Removal of CO 485 as an antirequisite as there is very little overlap in content between these two courses.
Current Catalog Information
ECE 464 (0.50) LAB, LEC, TST, TUT High Voltage Engineering and Power System Protection
The course provides the fundamentals concepts of generation and measurements of high
voltage ac, dc, and impulses. Briefly introduces the students to basic conduction and
breakdown mechanisms of insulating materials. The scope of this course also includes
understanding the basic protection system, studying the principles for protecting
different elements and studying different technologies used in designing protective
relays. Exposure to several state-of-art high voltage testing techniques of power
system components will ensure that students have knowledge of the industrial
solutions to the management of the problems associated with overvoltage and the
protection mechanisms used. [Offered: W]
No Special Consent Required
Requisites:
Prereq: ECE 260 or ECE 361; Level at least 4A Computer Engineering or
Electrical Engineering
Effective 01-SEP-2020
Requisite Change:
Prereq: One of ECE 260, 361, ME 269, MTE 320
Rationale:
The prerequisites are updated to allow Mechanical and Mechatronics
Engineering students to enrol in this course.

Current Catalog Information
ECE 484 (0.50) LAB, LEC, TUT Digital Control Applications
Dynamic system modeling: linear, nonlinear, state-space, sample data systems,
computer simulation, system identification. Discrete system stability and dynamic
performance. Nonlinear system analysis, limit cycles. Digital control system design:
emulation methods, z-domain, frequency domain, pole placement. Implementation of
digital controllers. Laboratory projects in computer control of mechatronic and other
systems. [Offered: F, W]
No Special Consent Required
Requisites:
Prereq: (MTE 360; Level at least 4A Mechatronics Eng) or (ME 360;
Mechanical Eng./Mechatronics Option) or (SYDE 352; Systems Design
Eng/Mechtr Option). Antireq: ECE 481
Effective 01-SEP-2020
Description Change:
Dynamic system modelling: linear, nonlinear, state-space, sample data
systems, computer simulation, system identification. Discrete system
stability and dynamic performance. Nonlinear system analysis, limit cycles.
Digital control system design: emulation methods, z-domain, frequency
domain, pole placement. Implementation of digital controllers. Laboratory
projects in computer control of mechatronic and other systems. [Offered: F]
Rationale:
Term offering is revised to reflect current teaching practice.

COURSE INACTIVATIONS (for approval)
Effective 01-SEP-2020
ECE 209 (0.50)  
Rationale: Electronic and Electrical Properties of Materials
This course is inactivated and will be replaced by a redesigned course (ECE 231) with new content.

Effective 01-SEP-2020
ECE 415 (0.50)  
Rationale: Multimedia Communications
This technical elective course is inactivated due to low enrolment.

Effective 01-SEP-2020
ECE 418 (0.50)  
Rationale: Communications Networks
This technical elective course is inactivated due to low enrolment.

End of Report
Electrical Engineering

The field of Electrical Engineering shares foundations from science, mathematics, and computing. Students gain the breadth and depth of understanding necessary for lifelong learning in any area of Electrical Engineering.

The Electrical Engineering plan starts out pre-structured and shares a common 1A, 1B and 2A terms with Computer Engineering. As students progress through the curriculum, and develop their interests, the plan provides students with choices that can further define their technical focus. The goal is to graduate students with solid core engineering competencies but highly customizable depth, breadth, and focus.

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 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 the Co-operative Education System apply, as further described in the Engineering Work Terms section 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.

Notes

1. Milestones have deadlines for successful completion and are shown in the terms 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) as per Rule 11 of the Examinations and Promotions Rules. 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/4B terms, students must enrol in the ECE 498A/ECE 498B sequence or the GENE 403/GENE 404 sequence. ECE 498A/GENE 404 and ECE 498B/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.

Legend for the tables below

The tables below outline the contents of the eight academic terms and six co-operative work terms. The ordering of the terms is as described in the Study/Work Sequence section. A student is assigned to one of the two Streams: 8 or 4F. The superscripts 8 and 4F are for information specific to Stream "8" and Stream "4F", respectively. For academic terms, the average scheduled hours per week are indicated in the columns Cls for class (LEC or SEM), Tut for tutorial (TUT), and Lab for laboratory (LAB or PRJ). Most laboratories are either open or scheduled every second or third week. Further details on electives and milestones are provided below.

<table>
<thead>
<tr>
<th>Term</th>
<th>Course or Milestone</th>
<th>Title and Notes</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
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<td>Fundamentals of Programming</td>
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<td>Engineering Profession and Practice, Technical</td>
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<td>ECE 106</td>
<td>Electricity and Magnetism</td>
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<td>Linear Circuits</td>
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<td>Engineering Economics and Impact on Society</td>
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<td>Co-operative Work Term</td>
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<td>Tactics for Workplace Success</td>
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<td>Advanced Calculus 1 for Electrical and Computer Engineers</td>
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<td>Co-operative Work Term</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Term, Fall, Winter</td>
<td>PD 20</td>
<td>Strategies for Career Success</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2B Spring, Fall</td>
<td>ECE 101C</td>
<td>Work-term Reflections (see note 1)</td>
<td>4F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2B Spring, Fall</td>
<td>ECE 101B</td>
<td>Work-term Reflections (see note 1)</td>
<td>4F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2B Spring, Fall</td>
<td>ECE 202</td>
<td>Information Session</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2B Spring, Fall</td>
<td>ECE 203</td>
<td>Probability Theory and Statistics 1</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2B Spring, Fall</td>
<td>ECE 206</td>
<td>Advanced Calculus 2 for Electrical Engineering</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2B Spring, Fall</td>
<td>ECE 207</td>
<td>Signals and Systems</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2B Spring, Fall</td>
<td>ECE 231</td>
<td>Semiconductor Physics and Devices</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>2B Spring, Fall</td>
<td>ECE 260</td>
<td>Electromechanical Energy Conversion</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>2B Spring, Fall</td>
<td>ECE 298</td>
<td>Instrumentation and Prototyping Laboratory</td>
<td>0</td>
<td>0</td>
<td>1.50</td>
</tr>
<tr>
<td>Work Term, Spring, Fall</td>
<td>COOP 3</td>
<td>Co-operative Work Term</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Term, Spring, Fall</td>
<td>One Professional Development Elective (see note 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3A Winter, Spring</td>
<td>ECE 101D</td>
<td>Work-term Reflections (see note 1)</td>
<td>4F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3A Winter, Spring</td>
<td>ECE 101C</td>
<td>Work-term Reflections (see note 1)</td>
<td>4F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3A Winter, Spring</td>
<td>ECE 301</td>
<td>Information Session</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3A Winter, Spring</td>
<td>ECE 318</td>
<td>Communication Systems 1</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>3A Winter, Spring</td>
<td>ECE 340</td>
<td>Electronic Circuits 2</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>3A Winter, Spring</td>
<td>ECE 375</td>
<td>Electromagnetic Fields and Waves</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>3A Winter, Spring</td>
<td>ECE 380</td>
<td>Analog Control Systems</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>One CSE, NSE, or TE (see note 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3B Fall</td>
<td>ECE 101D</td>
<td>Work-term Reflections (see note 1)</td>
<td>4F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3B Fall</td>
<td>ECE 301</td>
<td>Information Session 1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3B Fall</td>
<td>ECE 307</td>
<td>Probability Theory and Statistics 2</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>One CSE, NSE, or TE (see note 2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3B Fall</td>
<td>Choose two of the following four courses (see note 4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Work Term</th>
<th>COOP 5</th>
<th>Co-operative Work Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>ECE 101E</td>
<td>Work-term Reflections (see note 1)</td>
</tr>
<tr>
<td></td>
<td>ECE 401</td>
<td>Information Session</td>
</tr>
<tr>
<td></td>
<td>ECE 498A/GENE</td>
<td>Engineering Design Project/Interdisciplinary Design Project 1 (see notes 5 and 6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Four elective courses, CSE, NSE, or TE, as necessary (see note 2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Work Term</th>
<th>COOP 6</th>
<th>Co-operative Work Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td>ECE 402</td>
<td>Information Session</td>
</tr>
<tr>
<td></td>
<td>ECE 498B/GENE</td>
<td>Engineering Design Project/Interdisciplinary Design Project 2 (see notes 5 and 6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Four elective courses, CSE, NSE, or TE, as necessary (see note 2)</td>
</tr>
</tbody>
</table>

**Work-term Reflections**

For each of the Work-term Reflections (ECE 101) courses, 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 CR/NCR.

**Elective Courses**

**Complementary Studies Electives**

Students must complete three complementary studies elective (CSE) courses 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**

In addition to the core technical courses, students must understand and be able to apply the Engineering ethics. To meet this 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 elective (NSE) courses, and are responsible for ensuring they meet the minimum Academic Units (AUs). 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.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL 110</td>
<td>Introductory Zoology</td>
</tr>
<tr>
<td>BIOL 130 and BIOL 130L</td>
<td>Introductory Cell Biology/Cell Biology Laboratory</td>
</tr>
<tr>
<td>BIOL 150</td>
<td>Organismal and Evolutionary Ecology</td>
</tr>
<tr>
<td>BIOL 165</td>
<td>Diversity of Life</td>
</tr>
<tr>
<td>BIOL 211</td>
<td>Introductory Vertebrate Zoology</td>
</tr>
<tr>
<td>BIOL 240 and BIOL 240L</td>
<td>Fundamentals of Microbiology/Microbiology Laboratory</td>
</tr>
<tr>
<td>BIOL 241</td>
<td>Introduction to Applied Microbiology</td>
</tr>
<tr>
<td>BIOL 273</td>
<td>Principles of Human Physiology 1</td>
</tr>
<tr>
<td>BIOL 373 and BIOL 373L</td>
<td>Principles of Human Physiology 2/Human Physiology Laboratory</td>
</tr>
<tr>
<td>CHE 161</td>
<td>Engineering Biology</td>
</tr>
<tr>
<td>CHEM 123 and CHEM 123L</td>
<td>General Chemistry 2/General Chemistry Laboratory 2</td>
</tr>
<tr>
<td>CHEM 209</td>
<td>Introductory Spectroscopy and Structure</td>
</tr>
<tr>
<td>CHEM 237 and CHEM 237L</td>
<td>Introductory Biochemistry/Introductory Biochemistry Laboratory</td>
</tr>
<tr>
<td>CHEM 254</td>
<td>Introductory Chemical Thermodynamics</td>
</tr>
<tr>
<td>CHEM 262 and CHEM 262L</td>
<td>Organic Chemistry for Engineering/Organic Chemistry Laboratory for Engineering Students</td>
</tr>
<tr>
<td>CHEM 266</td>
<td>Basic Organic Chemistry 1</td>
</tr>
<tr>
<td>CHEM 356</td>
<td>Introductory Quantum Mechanics</td>
</tr>
</tbody>
</table>
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.
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.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 414</td>
<td>Communication Systems 2</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>ECE 417</td>
<td>Image Processing</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 433</td>
<td>Fabrication Technologies for Micro and Nano Devices</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 444</td>
<td>Integrated Analog Electronics</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 445</td>
<td>Integrated Digital Electronics</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 452</td>
<td>Software Design and Architectures</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 454</td>
<td>Distributed Computing</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 455</td>
<td>Embedded Software</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 457A</td>
<td>Cooperative and Adaptive Algorithms</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>ECE 458</td>
<td>Computer Security</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 462</td>
<td>Electrical Distribution Systems</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 463</td>
<td>Design &amp; Applications of Power Electronic Converters</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 475</td>
<td>Radio-Wave Systems</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 481</td>
<td>Digital Control Systems</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 486</td>
<td>Robot Dynamics and Control</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 493</td>
<td>Special Topics in Electrical and Computer Engineering (see note 7)</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 406</td>
<td>Algorithm Design and Analysis</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 409</td>
<td>Cryptography and System Security</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>ECE 416</td>
<td>Advanced Topics in Networking</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 423</td>
<td>Embedded Computer Systems</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 432</td>
<td>Radio Frequency Integrated Devices and Circuits</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 451</td>
<td>Software Requirements Specification and Analysis</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 453</td>
<td>Software Testing, Quality Assurance and Maintenance</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>ECE 457B</td>
<td>Fundamentals of Computational Intelligence</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>ECE 459</td>
<td>Programming for Performance</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 464</td>
<td>High Voltage Engineering and Power System Protection</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 467</td>
<td>Power Systems Analysis, Operations and Markets</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
<tr>
<td>ECE 474</td>
<td>Radio and Wireless Systems</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
</tr>
</tbody>
</table>
The following project elective is offered every term. Students may take it, at most, once as a TE course.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 499</td>
<td>Engineering Project</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

**Workplace Hazardous Materials Information System (WHMIS)**

Under both the federal and provincial legislation, 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.

**Available Options**

The curriculum in Computer Engineering is designed to offer a well-balanced and rewarding education. Students wishing to further enrich their studies may take any option, minor, or joint degree for which they meet the eligibility requirements (see the section on Engineering Interdisciplinary Alternatives). Options typically require extra courses and/or constrain the choice of elective courses. When taking courses from a different plan, the student may need to do extra work to compensate for a different background preparation. Time beyond the normal plan duration may be necessary due to the extra requirements and constraints on space or scheduling.

**Communications and Signal Processing Specialization**

We take for granted remote connection to complex services, which may involve high-quality video streaming, human-machine voice interaction, biometric monitoring, image or video understanding, and rapidly evolving forms of assistance using artificial intelligence. Indeed, many are possible from a cell phone barrelling down a highway or embedded on a massive scale in sensor networks. They hold promise of meaningful impact on global problems such as aging and health care, education, social cohesion, resource and environmental management, crime prevention, and countless applications yet to be imagined. Beyond applying known algorithms, engineers need to understand fundamental principles from communications and signal processing which are at the heart of sophisticated and powerful trade-offs in design. This specialization allows students to choose that depth of learning within various combinations of its two core topics.
Requirements

Students interested in pursuing this specialization must achieve an average of at least 60% in the specialization courses, and a grade of at least 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 1

Any three courses from the following list

ECE 358 Computer Networks
ECE 414 Communication Systems 2
ECE 416 Advanced Topics in Networking
ECE 417 Image Processing
ECE 474 Radio and Wireless Systems
Management Sciences Option

The Management Sciences Option (MSCI Option) prepares students for decision-making roles in business and technology management. The Option complements an engineer's technical training with a well-rounded education in management sciences, including studies of economics, organizational behaviour and design, decision analysis and operations research, production and service operations, information systems design, innovation, and technology strategy. Courses develop a conceptual understanding of management and organizational processes, practical skills to analyze and solve decision problems and implement business solutions, and an awareness of the impact of technology and innovation on organizations and society.

Legend

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>Fall term</td>
</tr>
<tr>
<td>W</td>
<td>Winter term</td>
</tr>
<tr>
<td>S</td>
<td>Spring term</td>
</tr>
</tbody>
</table>
| A,B,C,D | These courses count toward **Complementary Studies requirements**:  
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 undergraduate advisor in their home department for specific rules that apply to their plan. |

The MSCI Option consists of six courses, including three required courses (or their equivalents) and three elective courses (or equivalents). In order to gain a management science perspective during their option, students are required to have at least three of the six courses taught by the Department of Management Sciences. The three required MSCI Option courses and equivalents are:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title and Notes</th>
</tr>
</thead>
</table>
| MSCI 211<sup>C</sup> or MSCI 311<sup>C</sup> | Organizational Behaviour (F,W,S) - may be replaced by PSYCH 238  
Organizational Design and Technology (F,W)  
Engineering Economics: Financial Management for Engineers (F,W,S) - may be replaced by AE 392, BME 364, CIVE 392, ECE 390, ENVE 392, GEOE 392, or SYDE 262  
MSCI 261<sup>B</sup> |  
Introduction to Optimization (F,W,S) - may be replaced by BME 411, CIVÊ 332, CO 250, ENVE 335, or SYDE 411 |

plus three of the following elective courses or equivalents:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title and Notes</th>
</tr>
</thead>
</table>
| MSCI 211<sup>C</sup> | Organizational Behaviour (F,W,S) - may be replaced by PSYCH 238  
Managerial Economics (S) - may be replaced by ECON 201  
Organizational Design and Technology (F,W)  
Deterministic Optimization Models and Methods (F)  
Leadership and Influence (S) - may be replaced by BET 450  
Strategic Management of Technology (S)  
Economic Impact of Technological Change and Entrepreneurship (F)  
Managing New Product and Process Innovation (W)  
Stochastic Models and Methods (W) - may be replaced by CS 457 or SYDE 531  
Production and Service Operations Management (F,W)  
Advanced Optimization Techniques (W)  
Impact of Information Systems on Organizations and Society (W)  
Information Systems Analysis and Design (W) - may be replaced by CS 430 or CS 490  
Telecommunication Systems: from protocols to applications (W beginning 2021)  
Data Mining (F until 2020, W beginning 2021) [Note: new title effective winter 2021]  
Decision Making Under Uncertainty (S) |
### Requirements

- At least three of the six courses must be MSCI courses from the Department of Management Sciences.
- A maximum of one course from outside the approved list may be counted toward the Option, subject to written approval of the MSCI option co-ordinator and the associate chair of undergraduate studies in the student's home department. The student must complete a Course Substitution Request form to obtain course approval.
- 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.
- For the designation of Management Sciences Option to be shown on the transcript, the student must achieve a minimum overall cumulative average of 60% in the six courses.

Students have a wide degree of flexibility in course selection within the MSCI Option. For students who wish to focus on a particular theme within Management Sciences, the Department suggests the following selection of courses beyond the required set:

#### Theme

- **Operations Research**
  - Two or more of [MSCI 332](#), [MSCI 431](#), [MSCI 432](#), [MSCI 435](#), [MSCI 452](#), [MSCI 531](#), [MSCI 555](#)

- **Information Systems**
  - Two or more of [MSCI 442](#), [MSCI 444](#), [MSCI 445](#), [MSCI 446](#), [MSCI 541](#)

- **Management of Technology**
  - Two or more of [MSCI 311](#), [MSCI 411](#), [MSCI 421](#), [MSCI 422](#), [MSCI 423](#), [MSCI 454](#)

#### Note

Refer to the University's official [Schedule of Classes](#) for confirmation of actual course offerings each term.

For further information about the MSCI Option, contact the MSCI option co-ordinator in the Management Sciences Department.
COURSE CHANGES  (for approval)

Management Sciences

Current Catalog Information

MSCI  211  ( 0.50 )  LEC  Organizational Behaviour
Introduction to the concepts of learning, person perception, attitudes and motivation in an organization. Consideration of communication, roles, norms and decision making within a group. Discussion of power, control, leadership and management in light of the above concepts. [Offered: F, W, S]
No Special Consent Required
Requisites :  Antireq: AFM 280, BUS 288W, PSYCH 238/338

Effective  01-SEP-2020
Rationale :  The antirequisites are updated, adding SCBUS 225 due to overlap in course content which also lists MSCI 211 as an antireq.

Current Catalog Information

MSCI  251  ( 0.50 )  LAB, LEC, TUT  Probability and Statistics 1
A first of a two-course sequence that introduces fundamental concepts in probability and statistics. It covers probability concepts, random variables, graphical display of distributions and data, discrete and continuous probability distributions, sampling, estimation, confidence intervals, experimental design, hypothesis testing, and simple linear regression and correlation. Students learn how to graphically explore data, conduct and analyze a two-treatment experiment, and model data with linear regression, and interpret its fit. Students learn to use statistical computing software (e.g., R) to perform data analyses. Emphasis is placed on gaining experience with data collected from student-conducted experiments. [Offered: F]
No Special Consent Required
Requisites :  Prereq: Level at least 2A Management Engineering. Antireq: CHE 220, CIVE 224, ECE 316, ECON 221, ENVE 224, ME 202, NE 115/215, STAT 231, SYDE 212

Effective  01-SEP-2020
Requisite Change :  Prereq: Level at least 2A Management Engineering. Antireq: AE 224, BME 213, CHE 220, CIVE 224, ECE 316, ECON 221, ENVE 224, ME 202, MTE 201, NE 215, STAT 231, SYDE 212
Rationale :  The antirequisites are updated adding AE 224, BME 213, and MTE 201 due to overlapping content, and removing NE 115 as this course has not been offered for some time.

Current Catalog Information

MSCI  261  ( 0.50 )  LEC, TST, TUT  Engineering Economics: Financial Management for Engineers
Introductory Finance: time value of money, cash flow analysis. Investment evaluation

No Special Consent Required

Requisites :

Effective 01-SEP-2020

Requisite Change :

Prereq: Engineering students only. Not open to Architectural, Biomedical, Civil, Environmental, Geological, and Systems Design Engineering students. Antireq: AE 392, BME 364, CIVE 392, ECE 390, ENVE 392, GEOE 392, SYDE 262

Rationale :

Prerequisite added to prevent student enrolment errors. Antirequisites are updated adding AE 392, ENVE 392, and GEOE 392 due to overlapping course content, and ENVE 292 is removed as it has not been offered for some time.

Current Catalog Information

MSCI 422 (0.50) LEC Economic Impact of Technological Change and Entrepreneurship

This course is designed to analyze the impact of technological change and entrepreneurship at a firm and societal level, primarily in terms of the economic antecedents and consequences of new technology. The scope of the course ranges from the study of the determination of productivity and its effect on economic growth to the determination of innovative activity and performance. Prereq: (One of CIVE 292/392, ECON 101, ENVE 292/392, MSCI 261, SYDE 262) and (One of CHE 220, CIVE 224, ECE 316, ECON 221, ENVE 224, ENV S 278, KIN 222, MSCI 252 or 253, ME 202, MTE 201, NE 215, PSCI 314, PSYCH 292, REC 371, SDS 250R, SOC 280, STAT 202, 206, 211, 221, 231, 241, SYDE 212) and level at least 3A. [Offered: F]

No Special Consent Required

Requisites :

See course description for prerequisite details.

Effective 01-SEP-2020

Description Change:

This course is designed to analyze the impact of technological change and entrepreneurship at a firm and societal level, primarily in terms of the economic antecedents and consequences of new technology. The scope of the course ranges from the study of the determination of productivity and its effect on economic growth to the determination of innovative activity and performance. Prereq: (One of AE 392, BME 364, CIVE 392, ECON 101, ENVE 392, GEOE 392, MSCI 261, SYDE 262) and (One of AE 224, BME 213, CHE 220, CIVE 224, ECE 316, ECON 221, ENVE 224, ENV S 278, MSCI 251 or 252, ME 202, MTE 201, NE 215, PSCI 314, PSYCH 292, REC 371, SDS 250R, SOC 280, STAT 202, 206, 211, 221, 231, 241, SYDE 212) and level at least 3A. [Offered: F]

Rationale :

Prerequisites are updated adding AE 224, 392, BME 213, 364, ENVE 392, GEOE 392, and MSCI 251 as suitable prerequisites, and removing courses no longer appropriate such as CIVE 292, ENVE 292, KIN 222, MSCI 253 (MSCI 251 has enough background instead of requiring MSCI 253 as well), and NE 115 as it has not been offered for some time.

Current Catalog Information

MSCI 431 (0.50) LEC, TUT Stochastic Models and Methods
Introduction to Operations Research models and methods for problems with random, stochastic and probabilistic components. Topics include birth and death processes, branching processes, waiting line models, and Markov decision processes. Applications include, the design, modelling, and analysis of service and manufacturing systems, with emphasis on important functions such as queueing, inventory, reliability, equipment replacement, and maintenance. [Offered: W]

Requisites:
- Prereq: (One of BME 411, CIVE 332, CO 250, ENVE 335, MSCI 331 or SYDE 411) and (One of CHE 220, CIVE 224, ECE 316, ENVE 224, MSCI 252 or 253, ME 202, MTE 201, NE 115/215, STAT 206, 211, 231, 241, SYDE 212); Not open to stdnts in the Faculty of Math except SE

Effective 01-SEP-2020

Requisite Change:
- Prereq: (One of BME 411, CIVE 332, CO 250, ENVE 335, MSCI 331 or SYDE 411) and (One of AE 224, BME 213, CHE 220, CIVE 224, ECE 316, ENVE 224, MSCI 251 or 252, ME 202, MTE 201, NE 215, STAT 206, 211, 231, 241, SYDE 212); Not open to stdnts in the Faculty of Math except SE

Rationale:
- Prerequisites are updated adding AE 224, BME 213, and MSCI 251 as suitable prerequisites, and removing MSCI 253 (MSCI 251 has enough background instead of requiring MSCI 253 as well), and NE 115 as it has not been offered for some time.

Current Catalog Information

MSCI 432 (0.50) LEC, TUT Production and Service Operations Management
- Introduction to management, planning, and control decisions in manufacturing and service settings using quantitative approaches. Topic areas include production, inventory, distribution, quality control, facilities layout, and process design. Students are exposed to a number of examples and case studies, and work on a project that involves analysis and discussion of improved designs. [Offered: F, W]
- No Special Consent Required

Requisites:
- Prereq: (One of CHE 220, CIVE 224, ECE 316, ENVE 224, MSCI 252, ME 202, MTE 201, NE 115/215, STAT 206, 211, 231, 241, SYDE 212). Antireq: MSCI 334

Effective 01-SEP-2020

Requisite Change:
- Prereq: (One of AE 224, BME 213, CHE 220, CIVE 224, ECE 316, ENVE 224, ME 202, MTE 201, NE 215, STAT 206, 211, 231, 241, SYDE 212); Not open to Management Engineering students. Antireq: MSCI 334

Rationale:
- Prerequisites are updated adding AE 224, and BME 213 as suitable prerequisites, and removing courses no longer offered, such as MSCI 252 (was a Management Engineering core course), and NE 115 has not been offered for some time. This is a MSCI option course; the Management Engineering students take MSCI 334.

Current Catalog Information

MSCI 435 (0.50) LEC, TUT Advanced Optimization Techniques
- This course covers more advanced topics in optimization that go beyond the contents of MSCI 331 and MSCI 332. The course will cover topics such as constraint
programming, stochastic programming, large scale optimization, or complementarity
problems. [Offered: W]
No Special Consent Required
Requisites : Prereq: MSCI 331, 332

Effective 01-SEP-2020
Requisite Change : Prereq: MSCI 332
Rationale : Prerequisites are updated removing MSCI 331 as there are equivalents to
MSCI 331 listed in the MSCI 332 prerequisites.

Current Catalog Information
MSCI 452 (0.50) LEC, TUT Decision Making Under Uncertainty
This course deals with normative, descriptive, and prescriptive theories of decision
making under uncertainty. It begins with analytical models such as decision trees,
Bayes Theorem and Bayesian revision, value of information, basic utility theory and
multi-attribute decision making. The course continues with an examination of how
these theories can fail to predict actual decision making behavior. This course
applies the concepts of decision-making to managerial and consumer behavior as well
as behavior in negotiations. [Offered: S]
No Special Consent Required
Requisites : Prereq: One of CHE 220, CIVE 224, ECE 316, ENVE 224, MSCI 252 or 253, ME
202, MTE 201, NE 115/215, STAT 206, 211, 231, 241, SYDE 212

Effective 01-SEP-2020
Requisite Change : Prereq: One of AE 224, BME 213, CHE 220, CIVE 224, ECE 316, ENVE 224, MSCI
251 or 252, ME 202, MTE 201, NE 215, STAT 206, 211, 231, 241, SYDE 212
Rationale : Prerequisites are updated adding AE 224, BME 213, and MSCI 251 as suitable
prerequisites, and removing MSCI 253 (MSCI 251 has enough background
instead of requiring MSCI 253 as well).

Current Catalog Information
MSCI 454 (0.50) LEC Technical Entrepreneurship
Technical entrepreneurship is examined considering the role of independent business,
entrepreneurial behaviour, types of business and enterprises, business structure,
sources of venture concepts and capital, company operation and control, and business
start-up. [Offered: W]
No Special Consent Required
Requisites : Prereq: One of CIVE 292/392, ECE 390, ENVE 292, MSCI 261, SYDE 262; Level
at least 3A Engineering. Antireq: BET 300

Effective 01-SEP-2020
Requisite Change : Prereq: One of AE 392, BME 364, CIVE 392, ECE 390, ENVE 392, GEOE 392, MSCI
261, SYDE 262; Level at least 3A Engineering
Rationale : Prerequisites are updated adding AE 392, BME 364, ENVE 392, and GEOE 392 as
suitable prerequisites, and removing CIVE 292, and ENVE 292 as they are no
longer offered. It has been discovered that BET 300 is sufficiently
different from MSCI 454 so that they are no longer antirequisites.

Current Catalog Information
MSCI  541  (0.50) LEC, TUT  Search Engines
This course provides an opportunity for students to learn the engineering behind search engines and how to optimize search engines to provide higher quality user experiences. This course focuses on text retrieval and web search. Topics include design and construction of retrieval systems, retrieval models, and evaluation of search engines. [Offered: F, W, first offered Fall 2021, offered Winter until 2022]
No Special Consent Required
Requisites:
Prereq: (One of CS 240, ECE 250, MTE 140, SYDE 223) and (One of CHE 220, CIVE 224, ECE 316, ENVE 224, MSCI 252 or 253, ME 202, MTE 201, NE 115/215, STAT 206, 231, 241, SYDE 212)

Effective 01-SEP-2020
Requisite Change:
Prereq: (One of BME 122, CS 240, ECE 250, MSCI 240, MTE 140, SYDE 223) and (One of AE 224, CHE 220, CIVE 224, CIVC 212, ECE 316, ENVE 224, MSCI 251 or 252, ME 202, MTE 201, NE 215, STAT 206, 231, 241, SYDE 212)
Rationale:
Prerequisites are updated adding AE 224, BME 122, 213, and MSCI 251 as suitable prerequisites, and removing MSCI 253 (MSCI 251 has enough background instead of requiring MSCI 253 as well), and NE 115 has not been offered for some time.

Current Catalog Information
MSCI  551  (0.50) LEC, TUT  Quality Management and Control
The course focuses on the analysis, evaluation, and improvement of quality based on statistical tools. Topics include process capability analysis, statistical process control, experimental design and the Taguchi method, and acceptance sampling. The emphasis is on the assessment of quality and the design of alternate processes and/or quality assessment schemes to improve quality. [Offered: F]
No Special Consent Required
Requisites:
Prereq: One of CHE 220, CIVE 224, ECE 316, ENVE 224, MSCI 252 or 253, ME 202, MTE 201, NE 215, STAT 206, 231, 241, SYDE 212

Effective 02-SEP-2021
Requisite Change:
Prereq: One of AE 224, BME 213, CHE 220, CIVE 224, ECE 316, ENVE 224, MSCI 251 or 252, ME 202, MTE 201, NE 215, STAT 206, 231, 241, SYDE 212
Rationale:
Prerequisites are updated to allow easier access for other engineering students, adding AE 224, and BME 213 as suitable prerequisites. Also replacing MSCI 253 with 251 for management engineering students, as it has sufficient background without requiring MSCI 253 as well. [sarecord please note that this is another amendment to the September 1, 2021 change which has already been approved]
The five technical elective courses are to be chosen from the list below. 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 or three:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 362</td>
<td>Fluid Mechanics 2</td>
</tr>
<tr>
<td>ME 436</td>
<td>Welding and Joining Processes</td>
</tr>
<tr>
<td>ME 459</td>
<td>Energy Conversion</td>
</tr>
<tr>
<td>ME 524</td>
<td>Advanced Dynamics and Vibrations or SYDE 553 Advanced Dynamics</td>
</tr>
<tr>
<td>ME 548</td>
<td>Numerical Control of Machine Tools 1</td>
</tr>
<tr>
<td>ME 559</td>
<td>Finite Element Methods</td>
</tr>
<tr>
<td>ME 561</td>
<td>Fluid Power Control Systems</td>
</tr>
<tr>
<td>MTE 420</td>
<td>Power Electronics and Motor Drives or ECE 463 Design &amp; Applications of Power Electronic Converters (offered Spring)</td>
</tr>
<tr>
<td>MTE 460</td>
<td>Mechatronic System Integration</td>
</tr>
<tr>
<td>MTE 544</td>
<td>Autonomous Mobile Robots</td>
</tr>
<tr>
<td>MTE 545</td>
<td>Introduction to MEMS Fabrication</td>
</tr>
<tr>
<td>SYDE 533</td>
<td>Conflict Resolution</td>
</tr>
<tr>
<td>SYDE 543</td>
<td>Cognitive Ergonomics</td>
</tr>
<tr>
<td>SYDE 575</td>
<td>Image Processing</td>
</tr>
</tbody>
</table>

### Courses offered in the 4B (winter) term, choose two or three:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECE 327</td>
<td>Digital Hardware Systems</td>
</tr>
<tr>
<td>ECE 358</td>
<td>Computer Networks</td>
</tr>
<tr>
<td>ECE 429</td>
<td>Computer Architecture</td>
</tr>
<tr>
<td>ECE 457B</td>
<td>Fundamentals of Computational Intelligence</td>
</tr>
<tr>
<td>ECE 488</td>
<td>Multivariable Control Systems</td>
</tr>
<tr>
<td>ME 452</td>
<td>Energy Transfer in Buildings</td>
</tr>
<tr>
<td>ME 547</td>
<td>Robotic Manipulators: Kinematics, Dynamics, Control or ECE 486 Robotic Dynamics and Control</td>
</tr>
<tr>
<td>ME 555</td>
<td>Computer-Aided Design</td>
</tr>
<tr>
<td>ME 563</td>
<td>Turbomachines</td>
</tr>
<tr>
<td>ME 564</td>
<td>Aerodynamics</td>
</tr>
<tr>
<td>MTE 460</td>
<td>Mechatronic System Integration</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
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<td>-------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>MTE 546</td>
<td>Multi-sensor Data Fusion</td>
</tr>
<tr>
<td>SYDE 348</td>
<td>User Centred Design Methods</td>
</tr>
<tr>
<td>SYDE 372</td>
<td>Introduction to Pattern Recognition</td>
</tr>
<tr>
<td>SYDE 384</td>
<td>Biological and Human Systems</td>
</tr>
<tr>
<td>SYDE 522</td>
<td>Machine Intelligence</td>
</tr>
<tr>
<td>SYDE 542</td>
<td>Interface Design</td>
</tr>
<tr>
<td>SYDE 544</td>
<td>Biomedical Measurement and Signal Processing</td>
</tr>
<tr>
<td>SYDE 556</td>
<td>Simulating Neurobiological Systems</td>
</tr>
</tbody>
</table>
Biomedical Engineering

Specializations

Neural Engineering Specialization

Neural engineering is a discipline within biomedical engineering that is rapidly developing with high relevance to medicine. Four of the 10 highest-impact diseases in terms of years lost to disability are brain-related (World Health Organization, The Global Burden of Disease). Brain-inspired artificial systems are also rapidly emerging. Several Fortune-500 companies are pursuing computational brain modelling for the purpose of developing new brain-like technology.

The Neural Engineering Specialization will draw from the core Biomedical Engineering and Systems Design Engineering curriculum as well as introductory science and psychology courses, giving students a technical background in brain physiology, simulation and analysis methods, and brain-computer interfaces.

Requirements

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/GENE 403/SYDE 461 and BME 462/GENE 404/SYDE 462) with a focus on neuroscience applications. The project must be approved by the co-ordinator of the Neural Engineering Specialization. An average of at least 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 Faculty Options, Specializations and Electives for Engineering Students will have the appropriate designation shown on their diploma and transcript.

Required Courses

Note 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 (identified by A) can be counted towards Complementary Studies Requirements.

Note 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, as identified by an asterisk, where students will have the appropriate prerequisites.

- **BME 461** Biomedical Engineering Design Workshop 2 or **GENE 403** Interdisciplinary Design Project 1 or **SYDE 461** Systems Design Workshop 2 Capstone Project 1
- **BME 462** Biomedical Engineering Design Workshop 3 or **GENE 404** Interdisciplinary Design Project 2 or **SYDE 462** Systems Design Workshop 3 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*^A*
- **PSYCH 261** Physiological Psychology*
- **PSYCH 307** Human Neuropsychology^A*

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 487** Special Topics in Biomedical Signals (requires approval from the co-ordinator of the Neural Engineering Specialization)
- **BME 499** Elective Biomedical Research Project (requires approval from the co-ordinator of the Neural Engineering Specialization)
- **STAT 441** Statistical Learning – Classification
- **STAT 444** Statistical Learning – Function Estimation
- **SYDE 372 572** Introduction to Pattern Recognition*
- **SYDE 522** Machine Intelligence*
- **SYDE 552** Computational Neuroscience*
- **SYDE 556** Simulating Neurobiological Systems*

One additional course from either list A or B

**Sports Engineering Specialization**

Sports engineering has grown from a hobby of Isaac Newton and Lord Rayleigh to a multi-billion dollar industry, and today's athlete is highly dependent on the design and performance of their equipment and training systems. The modern sports engineer must be familiar with a wide range of topics ranging from sport biomechanics, and light-weight materials to mechatronic system dynamics and control.

The Sports Engineering Specialization will draw from the core Biomedical Engineering and Systems Design Engineering curriculum which are complemented by several technical elective courses in material science, image and signal processing, biomechanics, and sports engineering to give students specializing in sports engineering the broad range of skills required for this emerging discipline.

**Requirements**

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/GENE 403/SYDE 461 and BME 462/GENE 404/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. An average of at least 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 Faculty Options, Specializations and Electives for Engineering Students will have the appropriate designation shown on their diploma and transcript.

Required Courses

- BME 450 550 Sports Engineering
- BME 451 551 Biomechanics of Human Movement
- BME 461 Biomedical Engineering Design Workshop 2 or GENE 403 Interdisciplinary Design Project 1 or SYDE 461 Systems Design Workshop 2 Capstone Project 1
- BME 462 Biomedical Engineering Design Workshop 3 or GENE 404 Interdisciplinary Design Project 2 or SYDE 462 Systems Design Workshop 3 Capstone Project 2

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

- BME 488 Special Topics in Biomechanics
- BME 499 Elective Biomedical Research Project (requires approval from the co-ordinator of the Sports Engineering Specialization)
- CIVE 460 Engineering Biomechanics
- ECE 417 or SYDE 575 Image Processing
- KIN 340 Musculoskeletal Injuries in Work and Sport
- 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.

Faculty of Engineering Approved Options

The following is a list of Faculty-approved options:

Artificial Intelligence (Engineering)
Biomechanics
Computer Engineering
Environmental Engineering
International Studies in Engineering
Management Sciences
Mathematics
Mechatronics
Statistics
Water Resources

Students who complete the requirements for these a designated Faculty of Engineering approved Options will receive a final academic transcript with a statement that the Option has been successfully completed. Students should refer to the option section Options, Specializations and Electives for Engineering Students section of this Calendar for further information or contact the option co-ordinator.
COURSE CHANGES  (for approval)

Dean of Engineering

Current Catalog Information

BME  450  ( 0.50 )  LEC, TUT  Sports Engineering
This course focuses on the application of engineering principles to the analysis of
sports equipment and their effects on athletic performance. Principles of mechanics
are used to understand the motion and forces arising in sports equipment, and their
interaction with the musculoskeletal dynamics of athletes. [Offered: F]
Department Consent Required

Effective  01-SEP-2020
Subject/Catalog Nbr Change: BME 550
Rationale : This course is renumbered to make it available to MASc and MEng students.

Current Catalog Information

BME  451  ( 0.50 )  LEC, TUT  Biomechanics of Human Movement
This course introduces students to the biomechanics of the musculoskeletal system,
including motor control and rehabilitation engineering. Multibody models in
two-dimensional (2D) and three-dimensional (3D) will be used to study the dynamics of
normal and pathological motions. Motor control will be included, as well as the
identification of body segment parameters and the dynamics of muscles. Applications
may include assistive devices, rehabilitation, human gait, occupational biomechanics
and other activities. [Offered: W]
Department Consent Required

Effective  01-SEP-2020
Subject/Catalog Nbr Change: BME 551
Rationale : This course is renumbered to make it available to MASc and MEng students.

Systems Design Engineering

Current Catalog Information

SYDE  261  ( 0.50 )  LEC, TUT  Design, Systems, and Society
This non-technical course will help students understand how others think about
technology, and then use this knowledge to make better choices when designing,
specifying, choosing, and implementing technology. This course includes topics such
as meanings of design and their implications; designed in/designed out analysis;
reductionism and integration in design; the limits of objective thinking; alternate
ways to define function; content and context; "we/me/them/it" analysis; redefining
what constitutes acceptable technology; learning from the margins; reading design,
and understanding system boundaries as being defined by what we do rather than what
we say. [Offered: W]
No Special Consent Required

Requisites:
Prereq: 2A Systems Design Engineering. Antireq: STV 202

Effective 01-SEP-2020

Description Change:
This course will help students understand how others think about technology, and then use this knowledge to make better choices when designing. This impact course focuses on identifying, understanding, and analyzing the interactions and impacts among technology, society and the environment for current and emerging technologies using theoretical and evidence-based analyses. Connections among systems of systems engineering, impact analyses, evidence-based analyses, needs assessment, the design process, advocacy, and professional engineering will be discussed and applied. [Offered: W]

Requisite Change:
Prereq: 2A Systems Design Engineering

Rationale:
The revised course description better reflects the most recent updates made to SYDE 261. The removal of the antirequisite STV 202 is at the request of the Director of CSTV, as SYDE 261 and STV 202 no longer have significant overlap of content and/or focus.

Current Catalog Information
SYDE 361 (0.50) LAB, LEC, TUT Engineering Design

The methodology of design; defects, needs and the problem definition; criteria and generation of alternative solutions; feasibility analysis; optimization; selection, implementation and solution. The lecture material is supplemented by a term-long design project done in small groups. [Offered: S]

No Special Consent Required

Requisites:
Prereq: 3A Systems Design Engineering. Antireq: BME 361

Effective 01-SEP-2020

Title Change:
Systems Design Methods 1: Needs Analysis and Prototyping

Description Change:
The methodology of design, situation of concern; needs analysis and problem definition, engineering analysis and generation of alternative solutions, design prototyping, and design documentation. The lecture material is supplemented by a term-long design project done in small groups that develops hands-on experience with electromechanical prototyping. [Offered: S]

Rationale:
The revised course title and course description reflects the most recent updates made to the SYDE design curriculum.

Current Catalog Information
SYDE 362 (0.50) LAB, LEC Systems Design Workshop 1

Engineering design project course where students work in small groups applying the principles of engineering problem solving, systems analysis, simulation, optimization and design to a problem of their own choosing. Students have individual project supervisors as well as an overall coordinator who provides the framework for the term projects. [Offered: W]

No Special Consent Required
Requisites: Prereq: 3B Systems Design Engineering. Antireq: BME 362

Effective 01-SEP-2020
Title Change: Systems Design Methods 2: Testing, Verification, and Validation
Description Change: Engineering design project course where students work in small groups applying the principles of engineering problem solving and design, with a focus on testing and design evaluation, and an introduction to benchmark testing and applied design optimization. Student projects will provide hands-on experience with design verification, validation, and performance measurement and analysis using engineering tools. [Offered: W]

Rationale: The revised course title and course description reflects the most recent updates made to the SYDE design curriculum.

Current Catalog Information
SYDE 461 (0.50) LAB, LEC Systems Design Workshop 2
The first half of a two-term engineering design project continuing the systems design workshop sequence. An interim progress report is presented at the end of the first term. [Offered: F]
No Special Consent Required
Requisites: Prereq: 4A Systems Design Engineering. Antireq: BME 461

Effective 01-SEP-2020
Title Change: Systems Design Capstone Project 1
Description Change: The first half of a two-term engineering design project continuing the systems design project sequence. Students work in small groups applying the principles of systems design engineering to a situation of concern of their own choosing. Students have individual project supervisors as well as an overall co-ordinator who provides the framework for the term assessments. [Offered: F]

Rationale: The revised course title and course description reflects the most recent updates made to the SYDE design curriculum.

Current Catalog Information
SYDE 462 (0.50) LAB, LEC Systems Design Workshop 3
The concluding half of the fourth-year systems design workshop. [Offered: W]
No Special Consent Required

Effective 01-SEP-2020
Title Change: Systems Design Capstone Project 2
Description Change: The second half of a two-term engineering design project continuing the systems design project sequence. Students work in small groups applying the principles of systems design engineering to a situation of concern of their own choosing. Students have individual project supervisors as well as an overall co-ordinator who provides the framework for the term assessments. [Offered: W]

Rationale: The revised course title and course description reflects the most recent updates made to the SYDE design curriculum.
Current Catalog Information

**SYDE 332 (0.50) LEC, TUT**  Introduction to Complex Systems

The overwhelming majority of societal and ecological issues of pressing importance are complex systems; nonlinear interacting systems poorly characterized by linear analyses and Gaussian statistics. This course introduces the mathematics needed to understand such interactions, including nonlinear dynamics, critical and bifurcation behaviours, large-scale systems, power-law distributions, and statistical inference. The mathematical methods will be motivated by a set of case studies comprised of pressing large-scale interconnected problems such as global warming, energy shortages, desertification, overpopulation, poverty, and economic instability, to be investigated from a systems engineering perspective that will connect the mathematical analyses to real-world examples. [Offered: W]

No Special Consent Required

**Effective 01-SEP-2020**

**Subject/Catalog Nbr Change:** SYDE 532

**Rationale:** The original intention for the SYDE 3xx technical electives was to ensure that our SYDE 3B students had access to TEs that were scheduled with their core course schedules in mind. The topics are in specialized areas and taught at a level suitable for advanced students. The current reality is that the SYDE 3xx TEs are also taken by SYDE 4B, as well as upper year students from other programs and faculties. Renumbering as 5xx will allow the topic/course to be open to a subset of Masters level students coming from more traditional engineering programs who would otherwise not have sufficient specialized technical background to tackle more advanced 600-level courses. The prerequisites for the courses would remain in place to allow 3A BME and 3B SYDE and above to enrol.

Current Catalog Information

**SYDE 542 (0.50) LEC, TUT**  Interface Design

This course focuses on the design of computer interfaces for simple to complex systems. Examples of applications are used to illustrate theoretical approaches. Main topics include forms of visual display; auditory display and soft controls; context, navigation and layout; development techniques; design for engagement. [Offered: W]

No Special Consent Required

**Requisites:** Prereq: One of BME 162 or SYDE 162 or 348 or 543; Biomedical Engineering or Systems Design Engineering or (level at least 4A Mechatronics Engineering) or Ergonomics and Injury Prevention Minor

**Effective 01-SEP-2020**

**Requisite Change:** Prereq: One of BME 162, MSCI 343, SYDE 162, 348, 543; Biomedical Engineering or Systems Design Engineering or (level at least 4A Management Engineering or 4A Mechatronics Engineering) or Ergonomics and Injury Prevention Minor

**Rationale:** Management engineering students will have MSCI 343 as one of their core courses, thereby providing them with the requisite background for SYDE 542.
Updates to the prerequisites will allow management engineering students to enrol in SYDE 542 during the course selection period without the need for overrides.

**Current Catalog Information**

**SYDE 348 (0.50) LEC, TUT**

User Centred Design Methods

This course approaches the design of tasks, tools, products, and systems from a user-centered design perspective. Emphasis is on the human factors and usability methods, and techniques that can and should be applied throughout the iterative design process. While design issues pertaining to human-computer interaction are discussed, the methods presented can be applied to the design of almost any user interface. Major topics include; user research methods for usability and user experience, inspection methods, user testing, applied statistical analysis. [Offered: W]

No Special Consent Required

**Effective 01-SEP-2020**

**Subject/Catalog Nbr Change:** SYDE 548

**Rationale:**

The original intention for the SYDE 3xx technical electives was to ensure that our SYDE 3B students had access to TEs that were scheduled with their core course schedules in mind. The topics are in specialized areas and taught at a level suitable for advanced students. The current reality is that the SYDE 3xx TEs are also taken by SYDE 4B, as well as upper year students from other programs and faculties. Renumbering as 5xx will allow the topic/course to be open to a subset of Masters level students coming from more traditional engineering programs who would otherwise not have sufficient specialized technical background to tackle more advanced 600-level courses. The prerequisites for the courses would remain in place to allow 3A BME and 3B SYDE and above to enrol.

**Current Catalog Information**

**SYDE 372 (0.50) LEC, TUT**

Introduction to Pattern Recognition

Pattern recognition as a process of data analysis. Pattern features as components in a random vector representation. Classification techniques; distance measures in feature space, probabilistic (Bayesian) decision theory, linear discriminants. Clustering and feature extraction. Applications; optical character recognition, speech recognition, industrial robot vision, medical diagnosis, remote sensing and satellite image analysis, fault detection and diagnosis in complex systems such as nuclear reactors. [Offered: W]

No Special Consent Required

**Effective 01-SEP-2020**

**Subject/Catalog Nbr Change:** SYDE 572

**Rationale:**

The original intention for the SYDE 3xx technical electives was to ensure that our SYDE 3B students had access to TEs that were scheduled with their core course schedules in mind. The topics are in specialized areas and taught at a level suitable for advanced students. The current reality is that the SYDE 3xx TEs are also taken by SYDE 4B, as well as upper year
students from other programs and faculties. Renumbering as 5xx will allow the topic/course to be open to a subset of Masters level students coming from more traditional engineering programs who would otherwise not have sufficient specialized technical background to tackle more advanced 600-level courses. The prerequisites for the courses would remain in place to allow 3A BME and 3B SYDE and above to enrol.

Current Catalog Information

**SYDE 384 (0.50) LEC, TUT**

Biological and Human Systems

In this course, students will become familiar with the physiology and anatomical structures of the human body. The structure, functions and properties of the major biological systems (musculoskeletal, nervous, and cardiovascular) will be presented in relation to modeling biological systems and the design of biomedical devices (imaging, assistive and diagnostic). Various aspects of pathology and how they influence measurements will also be introduced. [Offered: W]

No Special Consent Required

Effective 01-SEP-2020

Subject/Catalog Nbr Change: SYDE 584

The original intention for the SYDE 3xx technical electives was to ensure that our SYDE 3B students had access to TEs that were scheduled with their core course schedules in mind. The topics are in specialized areas and taught at a level suitable for advanced students. The current reality is that the SYDE 3xx TEs are also taken by SYDE 4B, as well as upper year students from other programs and faculties. Renumbering as 5xx will allow the topic/course to be open to a subset of Masters level students coming from more traditional engineering programs who would otherwise not have sufficient specialized technical background to tackle more advanced 600-level courses. The prerequisites for the courses would remain in place to allow 3A BME and 3B SYDE and above to enrol.
Employment Opportunities

Graduates of systems design engineering will find employment opportunities in a number of diverse fields. To some extent, the technical elective area chosen by the student in the third and fourth year determines more specifically what the student does upon graduation. Some particular types of careers which systems design engineers may be involved with include:

- analysis and optimization of engineering systems
- simulation and advanced computer applications
- process control and instrumentation
- operations research
- development of alternative energy sources
- design of human-machine interfaces
- control systems design
- socio-economic systems design
- data analysis and pattern recognition
- occupational health and safety
- product design, planning and management
- ergonomics
- resources management
- research and development

These types of professional activities may fall within the domain of one or more engineering disciplines such as chemical, civil (e.g., structural, water resource, and transportation systems), electrical (e.g., circuit design and microprocessor applications), mechanical (e.g., energy conversion and design of machines), environmental (e.g., environmental impact assessment and planning), industrial, and human factors engineering.

Systems Design Engineering Curriculum

The undergraduate curriculum in systems design engineering encompasses the study of the basic skills required for systems analysis, simulation, optimization, and design. In particular the first three years of the plan are intended to provide each student with a broad background and capability in the areas of:

- engineering design
- applied mathematics
- engineering sciences and systems theory
- socio-economic systems
- human systems engineering
- computer systems and applications
Throughout these three years, the student's ability to grasp real engineering problems is enhanced by courses in systems design methodology followed by a series of challenging problem-solving experiences in the systems design workshops. It is here that a focus is given to the whole curriculum and the student learns to apply the lecture material, to develop skills in solving problems that cut across the traditional disciplines, and to develop design, planning, and organizational abilities.

The final year of the plan is comprised mostly of elective courses, allowing the student to emphasize one or more areas of study. This provides the required background for a future year of advanced study to the Master's (MASc) degree, or for a rewarding career in industry or government with the Bachelor's degree (BASc).

**Systems Design Engineering Core and Suggested Elective Curriculum (Listed by Terms)**

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.

A minimum of four complementary studies elective courses (CSEs) must be completed, in addition to the two complementary courses in the core (SYDE 261 and SYDE 262), in subjects that complement the engineering curriculum (see the Complementary Studies Electives section below). A minimum of six technical elective courses must be completed in a particular technical discipline or disciplines appropriate to a student’s interests (see the Technical Elective Packages section below). Course selections must meet CEAB requirements, including a minimum number of instruction hours in the various CEAB categories.

What follows is the current core course curriculum for systems design students entering 1A, with the course weight shown in square brackets [ ] next to each course. For those students who began the plan in 2018 or earlier, please consult the 2018-2019 Calendar. Students should contact the Systems Design Undergraduate Office for more details on the transition.

### 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] Fundamental Engineering Math 1
- **SYDE 113** [0.25] Matrices and Linear Systems
- **SYDE 121** [0.50] Digital Computation
- **SYDE 161** [0.50] Introduction to Design
- **SYDE 181** [0.50] Physics 1 (Statics)

### 1B (Spring)
SYDE 102  Seminar
SYDE 112 [0.50] Fundamental Engineering Math 2
SYDE 114 [0.25] Numerical and Applied Calculus
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

2A (Winter)

SYDE 201  Seminar
SYDE 182 [0.50] Physics 2 (Dynamics)
SYDE 211 [0.50] Advanced Engineering Math 1
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

2B (Fall)

SYDE 202  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
WKRPRT 200 [0.13] Work-term Report

3A (Spring)

SYDE 301  Seminar
SYDE 311 [0.50] Advanced Engineering Math 2
SYDE 351 [0.50] Systems Models 1
SYDE 361 [0.50] Engineering Design Systems Design Methods 1: Needs Analysis and Prototyping
SYDE 381 [0.50] Thermodynamics
SYDE 383 [0.50] Fluid Mechanics
WKRPRT 300 [0.13] Work-term Report

3B (Winter)
SYDE 302 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 Workshop 1 Systems Design Methods 2: Testing, Verification, and Validation
One Technical Elective
One Complementary Studies Elective

4A (Fall)

SYDE 401 Seminar
SYDE 411 [0.50] Optimization and Numerical Methods
SYDE 461 [0.50] Systems Design Workshop 2 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 Seminar
SYDE 462 [0.50] Systems Design Workshop 3 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 (CSEs)

The Complementary Studies requirement gives students some breadth of studies related to their role as educated professionals in society. In addition to the two courses in the core curriculum, at least four elective courses must be chosen to satisfy the Complementary Studies requirements. Only courses noted in Lists A, B, C, and D are Faculty-approved complementary studies electives. Students may arrange the
sequencing of the complementary studies elective courses to suit their plan (and any course prerequisites).

**Technical Studies Electives (TEs)**

Each undergraduate student in systems design engineering must complete at least six department approved technical electives 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. 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."

**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. However, students may find it possible to arrange their electives in such a way as to complete the requirements for one or more Faculty of Engineering approved Options. To do this, students with sufficiently high grades are encouraged, subject to approval from the associate chair for undergraduate studies, to supplement their plan with extra courses or courses taken online (see Centre for Extended Learning) or at another university.

**Human Systems Engineering**

The elective package in Human Systems Engineering offers students the opportunity to develop knowledge and skills applicable to the design and analysis of systems that interact closely with humans. This package draws upon the disciplines of engineering, psychology, and physiology in order to provide students with basic understandings of the capabilities and limitations of humans within a system context. The Department offers a selection of courses in the areas of human factors/ergonomics, as well as, image processing and biomedical engineering. Application-oriented courses show how human systems methods can be applied in the design of interactive systems, in biomedical and clinical systems, and in the industrial workplace. In addition, students are encouraged to select other courses to complement and strengthen their fundamental knowledge in their chosen fields of study. These might include courses in statistics and experimental design, cognitive and developmental psychology, perception and pattern recognition, signal processing and kinesiology, or biomechanics, and occupational health and safety.

The elective courses in this package are as follows:

**3B (Winter)**
4A (Fall)

SYDE 543  Cognitive Ergonomics  
SYDE 575  Image Processing

4B (Winter)

SYDE 372 572  Introduction to Pattern Recognition  
SYDE 384 584  Biological and Human Systems  
SYDE 542  Interface Design  
SYDE 544  Biomedical Measurement and Signal Processing

Intelligent Systems

The Intelligent Systems elective package provides a theoretical and methodological framework for the study of Information Engineering, an emerging field that includes artificial intelligence, robotics, communication, "smart" machines, and human-computer symbiosis. The systems-oriented approach emphasizes pattern analysis, since the recognition and classification of patterns is central to both human and machine intelligence, as well as, finding application in many subfields of engineering. Courses in artificial perception (Image Processing) and artificial reasoning (Machine Intelligence) provide focused views in key application areas. The intelligent systems field provides one of the richest environments in which to acquire the familiarity with algorithms and data structures essential for disciplined software system design.

Elective courses in this package are as follows:

3B (Winter)

SYDE 322  Software Design  
SYDE 372 572  Introduction to Pattern Recognition  
SYDE 531  Design Optimization Under Probabilistic Uncertainty  
SYDE 544  Biomedical Measurement and Signal Processing  
SYDE 552  Computational Neuroscience

4A (Fall)

SYDE 543  Cognitive Ergonomics  
SYDE 575  Image Processing

4B (Winter)

SYDE 348 548  User Centred Design Methods
Societal and Environmental Systems

When analyzing, operating, or designing a complex engineering project, a variety of interactions between the natural and social environment must be considered. Within this package are courses which present methodologies and techniques for formally studying societal and environmental systems from a systems design engineering perspective. Specifically, the courses are to provide a strong background in probability and statistics, economics, mathematical modelling (deterministic and stochastic), and decision methodologies. Additional experience can be gained by doing related workshop projects in SYDE 362, SYDE 461, and SYDE 462.

The courses in this elective package are:

3B (Winter)

SYDE 332 532 Introduction to Complex Systems  
SYDE 334 Applied Statistics  
SYDE 372 572 Introduction to Pattern Recognition

4A (Fall)

SYDE 531 Design Optimization Under Probabilistic Uncertainty  
SYDE 533 Conflict Resolution  
SYDE 575 Image Processing

4B (Winter)

SYDE 332 532 Introduction to Complex Systems  
SYDE 334 Applied Statistics  
SYDE 372 572 Introduction to Pattern Recognition  
SYDE 522 Machine Intelligence

Students enrolled in the Accelerated Master's Program in Engineering may also take:

SYDE 631 Time Series Modelling (fall)  
SYDE 632 Optimization (winter)

Finally, students studying courses in this package often take courses from a related Faculty Option such as Water Resources, Environmental Engineering, Management Sciences, or Statistics Option.
Systems Modelling and Analysis

The Systems Modelling and Analysis elective package offers the student a selection of elective courses that encompasses the theory, methods, and mathematics of engineering systems design. In modern engineering practice, a design engineer is increasingly confronted with complex projects involving a variety of interdisciplinary sub-systems. The engineer must understand the operation of each sub-system, and be able to integrate them together to achieve an efficient and appropriate solution to the overall problem. The Systems Modelling and Analysis elective package introduces modelling and analysis of deterministic and probabilistic systems, as well as, discrete and distributed parameter systems. The courses comprising the elective package emphasize analytical, as well as, computer based methods; the use of currently available computer aided analysis and design packages are encouraged.

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 for this package are as follows:

3B (Winter)

SYDE 372 572 Introduction to Pattern Recognition
SYDE 384 584 Biological and Human Systems
SYDE 552 Computational Neuroscience

4A (Fall)

SYDE 553 Advanced Dynamics
SYDE 575 Image Processing

4B (Winter)

SYDE 332 532 Introduction to Complex Systems
SYDE 372 572 Introduction to Pattern Recognition
SYDE 384 584 Biological and Human Systems
SYDE 552 Computational Neuroscience
SYDE 556 Simulating Neurobiological Systems

Faculty of Engineering Approved Options

Following is a list of Faculty approved options.

Artificial Intelligence (Engineering)
Biomechanics
Computer Engineering
Environmental Engineering
International Studies in Engineering
Students who complete the requirements of these a designated Faculty of Engineering approved Options will receive a final academic transcript from the University with a statement that the Option has been successfully completed. Students should refer to the Options, Specializations and Electives for Engineering Students section of this Calendar for further information or contact the option co-ordinator.

**Computer Option for Systems Design Engineering Students**

The aim of this Option is to augment the core curriculum from systems design engineering with technical elective courses from systems design engineering, electrical and computer engineering, and computer science so that students can acquire a strong background in both hardware and software aspects of computer systems. The focus is on software development and computer architecture.

In addition to the regular systems design core courses (SYDE 121, SYDE 223), the following two technical electives are mandatory for this Option:

**3B (Winter)**

SYDE 322 Software Design

**4B (Winter)**

CS 450 Computer Architecture or ECE 327 Digital Hardware Systems

In addition, four other technical electives must be taken from the following list. Where a set of courses overlaps significantly, students may take only one or two courses from the set, as indicated:

CS 360 Introduction to the Theory of Computing
CS 442 Principles of Programming Languages

Software Design and Architectures:
   At most one of CS 446 or ECE 452

Microprocessor Systems and Interfacing:
   At most one of ECE 224 or MTE 325

Distributed Systems:
   At most one of CS 454 or ECE 454

Communications, Signal and Image Processing:
   At most two of ECE 358, ECE 413, ECE 414, ECE 415, SYDE 575
Database Systems:
—— At most one of CS 348, CS 448, ECE 356

Machine Intelligence:
—— At most one of CS 486, ECE 457A, SYDE 372, SYDE 522

Computer Architecture:
—— At most one of CS 450 or ECE 429

Real-Time and Operating Systems:
—— At most one of CS 350, CS 450, CS 452, ECE 254, MTE 241

Interface Design:
—— At most one of CS 349 or SYDE 542
APPROVAL REQUIRED

1. ENV Courses – Attachment 1, p.2
   a. New
   b. Revised
   c. Inactivated

2. Plans
   a. Revisions
      i. Environment and Business – Attachment 2, p.14
      ii. International Development – Attachment 3, p.16

3. Subplan
   a. New
      i. Geography and Environmental Management: Aviation Specialization – Attachment 4, p.19
   b. Revisions
      i. Business Option – Attachment 5, p.21
      ii. GEM Specializations: Climate Change and Resource Management, Earth Systems Science, and Economy and Society – Attachment 6, p.22
      iii. Diploma in Ecological Restoration and Rehabilitation – Attachment 7, p.24

4. Calendar Text
   a. Approval required
      i. Audit Courses – Attachment 8, p.25

INFORMATION ONLY

5. Revision:
   a. Geography and Environmental Management Honours, Geography and Aviation, Geomatics Honours, and Joint Honours Geography and Environmental Management – Attachment 9, p.16

6. Other Business
For information only *(UGSC – SUC)*:

ERS 340 FLD,LEC,OLN 1.50  
Course ID: 014098

Ecosystem Assessment

An applied ecology course for those interested in becoming professional ecologists. In keeping with the Ecological Society of America’s Professional Ecologist Certification and the Society for Ecological Restoration's Certification Programme, intensive, multiple-weeks of field skill exercises are undertaken including advanced ecological sampling and experimental design, ecological sample analysis, use of provincially recommended protocols such as VSP (Vegetative Sampling Protocol), and intermediate to advanced taxonomic identification skills. May include certification and accreditation opportunities such as the Ontario Benthos Biomonitoring Network (OBBN) and the Ontario Stream Assessment Protocol and training in Electrofishing and Boating (for research). Location of the course will be within southern Ontario.

*[Note: Field trip fee normally is $1000+HST; it will not exceed $1500+HST.]*

*Department Consent Required*

*Prereq: Level at least 2B*

ERS 341 FLD,LEC,OLN 1.50  
Course ID: 014099

Professional Conservation and Restoration Practice I

An applied ecology course for those interested in becoming professional ecologists. In keeping with the Ecological Society of America’s Professional Ecologist Certification and the Society for Ecological Restoration's Certification Programme, an intensive, multiple-weeks field ecology project that students help design and then implement; students learn how to manage and perform ecosystem restoration and conservation projects.
Students also will improve practical site inventory and assessment skills for restoration and conservation goals. Projects may involve site constraints, and potential for bioengineering, bioremediation, vegetation installation and erosion-control measures. Location of the course will be within southern Ontario.

[Note: Field trip fee normally $250-700 +HST; will not exceed $1000 +HST.]

Department Consent Required

Coreq: ERS 340

Effective: Spring 2019
NEW COURSES  (for approval)

Geography & Environmental Management

Effective  01-SEP-2020

GEOG  205  ( 0.50 )  LAB, LEC  Principles of Geomorphology
This course introduces underlying principles of geomorphology using examples from subfields of the discipline. Topics include the role of time and scale in geomorphic processes, as well as the role of water, hill-slope processes, soils, wind, and glaciation and ice in polar and alpine environs.

Requisites : Prereq: One of GEOG 102, EARTH 121, EARTH 123. Antireq: ENVS 274 001 F19
Rationale : This course is designed to replace GEOG 201 as a foundations in geomorphology course. The current GEOG 201 (Fluvial Geomorphology) is too specialized for a foundations course, and will be renumbered GEOG 305 and the content tweaked to sequence from GEOG 205. Through the introduction of this course at the second year level, students will be well prepared to move through the 3rd and 4th year geomorphology streams in the program. The course will provide the necessary background information to students which is common to all threads in geomorphology.

Effective  01-SEP-2020

GEOG  274  ( 0.50 )  LEC, SEM, TUT  Special Topics in Geography
These courses allow for additions to the program on a short-term basis, and for the development of future permanent courses.

Requisites : Prereq: Level at least 1B
Rationale : Topic courses allow for additions to the program on a short-term basis, and for the development of future permanent courses. GEM currently offers topic courses at the 300 and 400 level, but not the 200 level. Department consent is required for enrollment into these courses.

Effective  01-SEP-2020

GEOG  302  ( 0.50 )  LEC, SEM  Geographies of Work and Employment
This course examines the spatial dimensions of work and employment, focusing not just on traditional spaces of work (e.g., the factory, the office), but also spaces of unpaid work in the home, forced work and slavery, migrant labour, and so on. Classes will include lecture content but emphasize student participation and discussion. Students will practice practical qualitative research skills by conducting semi-structured interviews.

Requisites : Prereq: Level at least 3A. Antireq: GEOG 374 001 F18
Rationale : This course is designed as part of the Economy and Society specialization in the Geography and Environmental Management undergraduate degree program.
The course is based on a labour and worker perspective, to complement some of the existing geography courses that are focused on spaces of global capital (GEOG202).

Planning - School of

Effective 01-SEP-2020

PLAN 415 (0.50) LAB, LEC, TUT Urban Planning and Development in Transitional China

This course offers a critical understanding of China's urban planning and development in the context of the country's economic reform and globalization. It engages with the ongoing social, economic, environmental, and spatial challenges facing transitional urban China. The course exposes students to diverse and essential issues such as urban form, urban system, rural-urban migration, urban land and housing development, economic transformation, spatial restructuring, urban governance, citizenship and rights, urban sprawl and expansion, and environmental sustainability.

Requisites:
Prereq: PLAN 261. Antireq: PLAN 474 001 W17, PLAN 474 001 W19

Rationale:
This course has been taught as a topics course between W14 - W17 and W19.

Effective 01-SEP-2020

PLAN 417 (0.50) LAB, LEC, TUT Aggregate Resources Planning, Development, and Management

This course introduces students to the planning and management of aggregate resources (sand, gravel, and stone). These resources are critical to infrastructure and urban development and are often subject to land use/environmental issues and conflicts. Course topics related to aggregate resources include relevant legislation, geology, economics, site plans, licensing, technical-peer reviews, water resources, pit and quarry rehabilitation and after-use strategies, and significant tribunal decisions. Emphasis will be on practical applications and 'real world' issues.

Course Attributes:
Also offered Online

Requisites:
Prereq: Level at least 3A Planning students only. Antireq: PLAN 474 001 F17, PLAN 474 001 F18, PLAN 474 001 F19

Rationale:
This course has been taught as a topics course since Fall 2015. Course may be offered either on-campus or online.

Environment, Enterprise & Development - School of

Effective 01-SEP-2020

ENBUS 310 (0.50) LEC Introduction to Sustainable Finance

In this course, the basics of sustainable finance will be explored. The course will cover topics such as green corporate finance, sustainability accounting, sustainable banking, climate finance, and social banking.

Course Attributes:
Only offered Online

Requisites:
Prereq: Level at least 2A. Antireq: ENBUS 409 081 W19

Rationale:
This course will build some depth in the area of sustainable finance.
Course was held W19 on-line as a special topics course which was well received. [Note: Offered on-line only.]

COURSE CHANGES (for approval)

Environment, Resources & Sustainability, School of

Current Catalog Information
ERS 270 (0.50) LEC Introduction to Sustainable Agriculture
Provides both survey and detailed examinations of the ethics, science, and techniques involved in sustainable agriculture. Topics normally include management of crops, soil, water, nutrients, wastes and pesticides, integrated pest management, organic farming, permaculture, ecological farm planning, use of genetically modified organisms, urban agriculture in developing nations, and innovations such as computer modelling and precision farming.
No Special Consent Required
Effective 01-SEP-2020
Title Change: Introduction to Sustainable Agroecosystems
Description Change: This course introduces and discusses the fundamental concepts of agroecology, the integration of agriculture and society, and the transition to sustainability. Topics include the impact of biotic and abiotic factors - including the use of genetically modified organisms - on crops, soil, and the agroecosystems.
Rationale: With advances in sustainable agriculture and the emerging field of agroecology, the course required updating. New material crosses disciplinary boundaries and emphasizes a systems approach to sustainable agriculture. It accommodates students with a diverse background and interest in agriculture and ecology.

Current Catalog Information
ERS 382 (0.50) FLD, LEC, OLN Ecological Monitoring
Through on-line readings and a ten day field trip, this course provides students with theoretical and practical knowledge of ecological monitoring through active participation in programs applying protocols developed by the Smithsonian Institute/Man and the Biosphere Program. The course is a collaborative effort with professional staff from selected governmental agencies, and independent organizations. [Note: Field trip fee normally $750+HST; will not exceed $1000+HST. Offered: After spring examinations, prior to the fall term.]
Instructor Consent Required
Requisites: Prereq: ENVS 200 or BIOL 150
Effective 01-SEP-2020
Unit Change: (1.00)
Rationale: The course is an intensive 10-day Spring term offering, where the students are out in the field working on a monitoring program. The time and effort
required by the students in the course merits a 1.0 credit weighting consistent with other field courses offered by SERS.

Geography & Environmental Management

Current Catalog Information

GEOG 201 (0.50) LEC, PRJ Fluvial Geomorphology
Emphasis on concepts related to fluvial processes, river mechanics, the relationship between environmental change and river regime. Selected topics include fluvial processes and landscape formation, flow and sediment regimes, channel processes, form and behaviour, river response to natural and anthropogenic change, and river management.

No Special Consent Required

Effective 01-SEP-2020

Subject/Catalog Nbr Change: GEOG 305
Description Change: Emphasis on concepts related to fluvial processes, river mechanics, the relationship between environmental change and river regime. Selected topics include fluvial processes and landscape formation, flow and sediment regimes, channel processes, form and behaviour, river response to natural and anthropogenic change, and river management. [Note: formerly GEOG 201]

Requisite Change:
Prereq: GEOG 205 or ENVS 274 001 F19 or level at least 2A Environmental Sciences, Water Science Specialization students. Antireq: GEOG 201

Rationale: The introduction of a general geomorphology course (GEOG 205) will allow this course to be more narrowly focused on Geomorphology. Note: Faculty of Science has been consulted.

Current Catalog Information

GEOG 336 (0.50) LEC, SEM Spaces of Citizenship: Identities and Inequality
This course uses international case studies to explore the geographies of citizenship, above and below the scale of the state. It examines how acts of citizenship affect people's sense of identity, community, well-being, and belonging.

No Special Consent Required
Requisites: Prereq: GEOG 202 or Level at least 3A Faculty of Environment students only.
Antireq: GEOG 374 001 F17

Effective 01-SEP-2020

Title Change: Space, Power, and Politics: Citizenship in a Changing World
Description Change: This course uses international case studies to examine how people interact with the state. These state-society relations include the experience of migrants, community volunteers, protestors, voters, environmental activists, and young people. Real world issues are incorporated throughout to understand how diverse groups of people create, debate, and contest the nation-state.

Requisite Change:
Prereq: GEOG 101; Level at least 3A. Antireq: GEOG 374 001 F17
Rationale: The title and description have been revised to better reflect the course content. The prerequisites have been adjusted to open this course to all UW students. Students will gain sufficient knowledge for course content in
GEOG 101.

Current Catalog Information
GEOG 315 (0.50) SEM Aviation Sustainability
An exploration of how sustainability is sought within the international aviation industry. The course takes a cross-sectional approach to aviation, exploring sustainability within the various sectors that make up the air transport system (e.g., air law, aircraft, operations, navigation, airports, and safety). Both the positive and negative impacts of aviation upon the sustainable development goals will be analyzed through reviewing case studies and industry practices. [Note: Prior completion of AVIA 100 is recommended.]
Instructor Consent Required
Cross-listed as: AVIA 315
Effective 01-SEP-2020
Subject/Catalog Nbr Change: GEOG 416
Unit Change: (1.00)
Component Change: PRJ, SEM
Description Change: An exploration of how sustainability is sought within the international aviation industry. The course takes a cross-sectional approach to aviation, exploring sustainability within the various sectors that make up the air transport system (e.g., air law, aircraft, operations, navigation, airports, and safety). Both the positive and negative impacts of aviation upon the sustainable development goals will be analyzed through reviewing case studies and industry practices. This course includes significant student project teamwork. [Note: formerly AVIA/GEOG 315]
Consent Change: No Special Consent Required
Requisite Change: Prereq: AVIA 100; Level at least 2A. Antireq: GEOG 474/AVIA 374 001 W18, GEOG 315/AVIA 315
Rationale: This course is being redeveloped as a capstone course for the Aviation Specialization. Students are required to work on problem statements (of real-world challenges) throughout the semester and present their final solutions to a panel of industry experts at the end of term; therefore, a PRJ component has been added. The course number is changed from a 300-level to a 400-level number, and the unit is increased to 1.0 to reflect the amount of work required for the course. Instructor consent is removed, and requisites are updated (formerly: Prereq: Level at least 2A. Antireq: GEOG 474 001 W18).

Current Catalog Information
GEOG 456 (0.50) FLD, LEC Transforming Canadian Resource Management
Past and present approaches to resource management in Canada are examined in order to design the transformations needed for a sustainable Canadian future. [Note: This course involves a combination of lecture, class discussion and activities, student presentations and a multi-day field trip to Ottawa; field trip fee normally $300+HST; will not exceed $600+HST. For students unable to attend the field component, an alternative assessment component will be arranged.]
No Special Consent Required

Requisites:
Prereq: Level at least 4A Faculty of Environment students only. Antireq: GEOG 474 001 W18

Effective 01-SEP-2020

Unit Change: (1.00)

Description Change:
This course builds on thematic areas of climate change, resource management, and sustainability. The evolution of Canadian resource management is traced from subsistence, utilitarian, and intrinsic value perspectives. The current state of resource management is critically evaluated, and alternative ways of thinking about conservation programming will be considered. [Note: This course involves a combination of lecture, class discussion and activities, student presentations, and a required multi-day field trip to Ottawa; field trip fee normally $300+HST; will not exceed $600+HST. Field trip dates will be determined no later than the end of the first week of lectures.]

Requisite Change:
Prereq: Level at least 4A Faculty of Environment students only. Antireq: GEOG 474 004 W18.

Rationale:
The course description has been rewritten to accurately reflect course content. This course is delivered in combination with a grad version, and the weight change reflects both the nature and volume of work required for the expected deliverables. This course will now fulfill the capstone requirement for the Climate Change and Resource Management specialization. The field trip is now mandatory. This course is not core for any GEM plan or specialization.

Environment, Enterprise & Development - School of

Current Catalog Information

ENBUS 402A (1.00) PRJ, WSP Environment and Business Project
The application of the principles learned in earlier courses will focus on a particular project. Applications may include group projects of sufficient scope to demonstrate mastery of problem-solving, integration, and communication on a selected topic related to environment and business, or on selected environmental issues related to a specific business operation. [Note: An all-day retreat will be scheduled for the first Friday of term. Instructor must be informed if student is unable to attend.]

No Special Consent Required

Requisites:
Prereq: ENBUS 302; Environment and Business students only. Antireq: ENBUS 403A

Effective 02-SEP-2020

Requisite Change:
Prereq: ENBUS 302 or ENBUS 306; Level at least 4A Environment and Business or International Development students only. Antireq: ENBUS 403A

Rationale:
ENBUS 402A/B is being opened to International Development students. See International Development Honours agenda item for more information.
Current Catalog Information
ENBUS  402B (0.50) PRJ Environment and Business Project
A continuation of ENBUS 402A. [Note: Course fee $30-$60]
No Special Consent Required
Requisites:
Prereq: ENBUS 402A; Environment and Business students only. Antireq: ENBUS 403B
Effective 02-SEP-2020
Requisite Change:
Prereq: ENBUS 402A. Antireq: ENBUS 403B
Rationale:
ENBUS 402A/B is being opened to International Development students. See International Development Honours agenda item for more information.

Current Catalog Information
INDEV 490A (0.50) ESS Honours Thesis: Project Preparation
The Honours Thesis/Project provides students with an opportunity to pursue a specific research topic or applied project of their choosing relating to the study of International Development. The paper will be prepared over two semesters. 490A involves the guided preparation of a research/project proposal.
No Special Consent Required
Requisites:
Prereq: Level at least 4A; International Development students only
Effective 01-SEP-2020
Consent Change:
Department Consent Required
Rationale:
Department consent added as this course will now be restricted to 4A INDEV students who have secured a thesis supervisor and have had their proposed thesis topic approved by the director undergraduate studies, SEED.

Interdisciplinary Studies

Current Catalog Information
AVIA 310 (0.50) LAB, LEC Human Factors in Aviation
A case study-influenced course emphasizing the need for pilots to recognize and improve interpersonal skills for problem solving and conflict management. Components introduce Crew Resource Management (CRM), the human component of the human-technology interface, and the cumulative act effect.
No Special Consent Required
Requisites:
Prereq: Level at least 2A Science and Aviation or Geography and Aviation students only
Effective 01-SEP-2020
Description Change:
An exploration of aviation non-technical skills and their impact on aviation safety and operational performance. Components explore workload, management, situational awareness, decision-making, and crew coordination.
Requisite Change:
Prereq: AVIA 100; Level at least 2A
Rationale:
AVIA 100 is added as a prerequisite to support Geography and Environmental Management and Geomatics students pursuing the Aviation Specialization (effective September 2020), in addition to Geography and Aviation and
Science and Aviation students enrolling in this course. The description is updated to better align with the course structure and content.

Current Catalog Information
AVIA 315 (0.50) SEM Aviation Sustainability
An exploration of how sustainability is sought within the international aviation industry. The course takes a cross-sectional approach to aviation, exploring sustainability within the various sectors that make up the air transport system (e.g., air law, aircraft, operations, navigation, airports, and safety). Both the positive and negative impacts of aviation upon the sustainable development goals will be analyzed through reviewing case studies and industry practices. [Note: Prior completion of AVIA 100 is recommended.]
Instructor Consent Required
Cross-listed as: GEOG 315
Effective 01-SEP-2020
Subject/Catalog Nbr Change: AVIA 416
Unit Change: (1.00)
Component Change: PRJ, SEM
Description Change: An exploration of how sustainability is sought within the international aviation industry. The course takes a cross-sectional approach to aviation, exploring sustainability within the various sectors that make up the air transport system (e.g., air law, aircraft, operations, navigation, airports, and safety). Both the positive and negative impacts of aviation upon the sustainable development goals will be analyzed through reviewing case studies and industry practices. This course includes significant student project teamwork. [Note: formerly AVIA/GEOG 315]
Consent Change: No Special Consent Required
Requisite Change: Prereq: AVIA 100; Level at least 2A. Antireq: GEOG 474/AVIA 374 001 W18, GEOG 315/AVIA 315
Rationale: This course is being redeveloped as a capstone course for the Aviation Specialization. Students are required to work on problem statements (of real-world challenges) throughout the semester and present their final solutions to a panel of industry experts at the end of term; therefore, a PRJ component has been added. The course number is changed from a 300-level to a 400-level number, and the unit is increased to 1.0 to reflect the amount of work required for the course. Instructor consent is removed, and requisites are updated (formerly: Prereq: Level at least 2A. Antireq: GEOG 474 001 W18).

Current Catalog Information
AVIA 320 (0.50) LEC, TUT Aviation Safety
This course is an advanced exploration of how aviation safety is managed at the organizational level. Content will include explorations of pilot threat and error management, safety management systems (including risk analysis and hazard identification), and safety audits. The focal point of the course is on understanding the nature and causation of accidents. [Offered: W]
No Special Consent Required

**Effective 01-SEP-2020**

**Subject/Catalog Nbr Change:** AVIA 417

**Component Change:** PRJ, SEM

**Description Change:** This course is an advanced exploration of how aviation safety is managed at the organizational level. Content will include explorations of pilot threat and error management, safety management systems (including risk analysis and hazard identification), and safety audits. The focal point of the course is on understanding the nature and causation of accidents. This course includes significant student project teamwork. [Offered: W]

**Requisite Change:** Prereq: AVIA 310; Geography and Aviation or Science and Aviation students only

**Rationale:**
This course has become a capstone experience for students within the Geography & Aviation and Science & Aviation programs. A significant amount of independent research and a total of four presentations and written assignments are required as groups work through solutions to industry safety issues. Student groups are expected to draw from their previous coursework and flight experience when crafting their solution. The course number is changed from a 300-level to a 400-level course to reflect that this course provides a culminating experience and fits best at the end of the program. The component type is change from LEC and TUT to SEM and PRJ to reflect the work required within the course. This course remains limited to those pursuing the pilot-focused aviation programs.

**Current Catalog Information**

AVIA 474 (0.50) LEC, SEM, TUT Special Topics in Aviation

An advanced special topics course offered in a particular branch of aviation, subject to availability of instructor.  

Department Consent Required

**Requisites:** Prereq: Honours Aviation students

**Effective 01-SEP-2020**

**Requisite Change:** Prereq: Level at least 2A Honours Aviation or Aviation Specialization students

**Rationale:**
Prerequisites are updated to allow access to students pursing the Aviation Specialization.

**Current Catalog Information**

AVIA 475 (0.50) RDG Independent Studies of Selected Topics

Individual study of special topics not covered in other aviation courses. Students will not be given permission to register for this course until a faculty member has agreed to supervise the study and the student has developed a brief outline of study to be approved by the Director of Aviation.  

Department Consent Required

**Requisites:** Prereq: Level at least 3A Honours Aviation

**Effective 01-SEP-2020**
Requisite Change: 
Prereq: Level at least 3A Honours Aviation or Aviation Specialization students

Rationale: 
Prerequisites are updated to allow access to students pursuing the Aviation Specialization.
To: Senate Undergrad Council  
From: Brendon Larson, Associate Dean Undergraduate Studies, Faculty of Environment  
Date: October 8, 2019  
Re: Revision: Environment and Business


Year Two

ECON 102 Introduction to Macroeconomics  
ENBUS 202 Environmental Management Systems  
ENBUS 203 Green Entrepreneurship  
ENBUS 204 Principles of Industrial Ecology  
ENVS 105 Environmental Sustainability and Ethics  
ENVS 200 Field Ecology  
ENVS 278 Applied Statistics for Environmental Research

One of:  
ENBUS 211 Principles of Marketing for Sustainability Professionals  
MGMT 244 Principles of Marketing

One course from the following:

ENBUS 307 Industrial Ecology: Life Cycle Assessment and Management in Business  
ENBUS 308 Sustainability Management Standards and Auditing  
ENBUS 309 Applied Social Marketing  
**ENBUS 310 Introduction to Sustainable Finance**  
ENBUS 314 Sustainable Business Models  
ENBUS 375 Special Topics in Environment and Business  
HRM 200 Basic Human Resources Management  
INDEV 308 Introduction to Social Entrepreneurship  
PHIL 215 Professional and Business Ethics

Plus one elective for a total of 5.0 units

Year Three

ECON 371 Business Finance 1  
ENVS 201 Introduction to Canadian Environmental Law  
ENVS 220 Ecological Economics  
ENBUS 302 Strategies for Environment and Business
ENBUS 306 Research Design  
ERS 215 Environmental and Sustainability Assessment I

One course from the following:

ENBUS 307 Industrial Ecology: Life Cycle Assessment and Management in Business  
ENBUS 308 Sustainability Management Standards and Auditing  
ENBUS 309 Applied Social Marketing  
ENBUS 310 Introduction to Sustainable Finance  
ENBUS 314 Sustainable Business Models  
ENBUS 375 Special Topics in Environment and Business  
HRM 200 Basic Human Resources Management  
INDEV 308 Introduction to Social Entrepreneurship  
PHIL 215 Professional and Business Ethics

Plus three electives for a total of 5.0 units

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Motion: Approve addition of ENBUS 310 as a theme elective.

Rationale: ENBUS 310 is a new course.

Effective: September 2020
To: Senate Undergrad Council  
From: Brendon Larson, Associate Dean Undergraduate Studies, Faculty of Environment  
Date: October 8, 2019  
Re: Revision: International Development

2020/21: [Link to UWaterloo Calendar](http://ugradcalendar.uwaterloo.ca/page/ENV-Honours-International-Development-Requirement)

Legend

± Students opting to complete ENBUS 402A/B in Year Four for the Research Specialization must successfully complete ENBUS 306 prior to enrolment.

*The International Development capstone event is a mandatory component of INDEV 402. The event is scheduled during the last week of April and first week of May.

Year Three

[INDEV 200](#) The Political Economy of Development  
[INDEV 300](#) Culture and Ethics  
[INDEV 308](#) Introduction to Social Entrepreneurship  
[INDEV 387](#) Global Cities in Global Development  
[ENBUS 309](#) Applied Social Marketing  
[ERS 315](#) Environmental and Sustainability Assessment II  
[MSCI 211](#) Organizational Behaviour

one of:

[INDEV 300](#) Culture and Ethics  
[INTEG 221](#) The Social Nature of Knowledge  
[PHIL 202/GSJ 222](#) Gender Issues

one of:

[ENBUS 306](#) and [two electives](#)†  
Three electives

Total 5.0 units

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Year Four

Practice Specialization
INDEV 401 International Development Placement 1 (1.5 units)
INDEV 402* International Development Placement 2 (1.5 units)
INDEV 476 Contemporary Issues in Development Practice
Three electives

Total 5.0 units

Research Specialization

INDEV 404 International Development Theory
INDEV 475 Contemporary Development Issues

One of:
INDEV 490A/INDEV 490B Honours Thesis: Project Preparation/INDEV 490B Honours Thesis: Project Completion (1.5 unit)
ENBUS 402A/ENBUS 402B Environment and Business Project (1.5 units)

Five electives

Total 5.0 units

Community Service Experience Requirement

The International Development, Research Specialization requires the completion of a pre-approved community service experience or educational seminar focused on community development issues of at least three weeks duration in Canada or internationally. Pre-approval is required by the International Development Field Placement Coordinator (INDEV FPC). This requirement must be organized by the student with support from the INDEV FPC and is to be completed at the student’s own expense.

Motion: Approve changes as presented.

Rationale:
Addition of INTEG 221 and PHIL 202/GSJ 222 to year 3: The benefits of the addition of this option for INDEV students are two-fold. First, this allows students three terms (as opposed to two) in 3rd year over which to complete their courses. Second, given the predominance of gender issues encountered by students on placement, more options for exploring these concepts will better prepare students for their time overseas. Consultation with INTEG, PHIL and GSJ departments has occurred.

Addition of ENBUS 402A/B to year 4: This provides the student with an opportunity to either complete a capstone project on a related development topic with a development partner (e.g.,
Mennonite Economic Development Associates (MEDA), or for supervised international development research (INDEV 490A/B).

Removal of the Community Service Experience Requirement: The 3-week volunteer service requirement for INDEV thesis stream is not integrated into coursework and does not add much value to the INDEV program. Requiring students to complete this milestone without clear pedagogical justification and connection to the program adds an undue burden on students who are working and/or studying full-time.

**Effective: September 2020**
To: Senate Undergrad Council  
From: Brendon Larson, Associate Dean Undergraduate Studies, Faculty of Environment  
Date: October 8, 2019  
Re: New: Aviation Specialization for Geography and Environmental Management

2020/2021 calendar: [http://ugradcalendar.uwaterloo.ca/page/ENV-Bachelor-Environmental-Stds-Specializations](http://ugradcalendar.uwaterloo.ca/page/ENV-Bachelor-Environmental-Stds-Specializations)

Students majoring in Honours Geography and Environmental Management, Geography and Aviation, Geomatics, or who are pursuing a Geography and Environmental Management joint degree, may choose to graduate with one specialization. Specializations are not available to students pursuing a Geomatics joint degree. Refer below for the requirements listed for each specialization. Upper-year courses may not be taken without the appropriate prerequisites. Upon completion of the requirements of both the degree and the specialization, students must indicate their area of specialization on their Application to Graduate.

Courses Offered by Specialization

Legend

*To count GEOG 490A/GEOG 490B toward the specialization, the thesis topic must focus on an area relevant to the specialization.

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**Proposed new calendar text:**

**Aviation Specialization**

The Aviation Specialization is also available to Geography and Environmental Three Year General students; however, it is not available to Honours Geography and Aviation students

Legend:

± Up to 1.0 unit will be waived from the List A elective requirement (not including the capstone course requirement) based on prior successful completion of ‘Professional Pilot Program’ flight courses, or if a student has held a Transport Canada Private Pilot Licence. Proof of Transport Canada Private Pilot Licence must be provided and be approved by the Geography and Aviation associate chair undergraduate studies prior to declaring this Specialization.

**Required Courses:**

AVIA 100 Introduction to Aviation  
GEOG 207 Climate Change Fundamentals  
GEOG 281 Introduction to Geographic Information Systems (GIS)
Elective Courses:

At least 3.0 units from List A, including at least one capstone course
At least 1.0 unit from List B

List A±:
AVIA 270/GEOG 270 Remotely Piloted Aircraft Systems (RPAS) Knowledge Requirements
AVIA 310 Human Factors in Aviation
AVIA 374 Special Topics in Aviation
AVIA 474 Special Topics in Aviation
AVIA 475 Independent Studies of Selected Topics
GEOG 202 Geography of the Global Economy
GEOG 233 Geography of Tourism
GEOG 309 Physical Climatology

Capstone Courses:
GEOG 416/AVIA 416 Aviation Sustainability (1.0 unit)
GEOG 490A/GEOG 490B Honours Thesis Preparation/ Thesis Completion* (1.5 unit)

List B:
GEOG 306 Human Dimensions of Natural Hazards
GEOG 307 Societal Adaptation to Climate Change
GEOG 323 Perspectives on International Tourism
GEOG 325 Geographies of Health
GEOG 351 Geography of Transportation
GEOG 423 Sustainable Tourism

One of:
GEOG 316 Multivariate Statistics
GEOG 318 Spatial Analysis

Motion: Approve new specialization as presented.

Rationale: This academic foundation in Geography and Environmental Management and Aviation will establish a pathway into ground-based aviation careers (such as airline dispatcher, air traffic controller, airport operations/environmental management, and airline carbon offsetting). Previous flight training is an asset within the specialization, but not a requirement. The Aviation Specialization would allow students who withdraw from an Aviation program to graduate with an ‘aviation’ designation on their Geography and Environmental Management degree. The Aviation specialization is available to the 3 yr. Geography and Environmental Management BES. This provides opportunities for students that may have previous aviation industry experience and want to upgrade their credentials to a university degree.

Effective: September 2020
To: Senate Undergrad Council  
From: Brendon Larson, Associate Dean Undergraduate Studies, Faculty of Environment  
Date: October 8, 2019  
Re: Revision: Business Option

2020/2021 calendar: http://ugradcalendar.uwaterloo.ca/page/ENV-Options

Business Option

Legend

*Neither AFM 101 nor AFM 131, and/or MGMT 244, if counted as a required course, cannot be used a second time to satisfy the elective course requirement.

A Business Option is available to all undergraduates in the Faculty of Environment, with the exception of students in the Environment and Business Honours program. It may not be combined with the Human Resources Management Minor or the Management Studies Minor because of similar coursework.

The requirements for the Option are eight courses (five core and three elective) with a minimum overall cumulative average of 65%.

Required Courses

One of: AFM 101, BUS 127W
One of: AFM 131, BUS 111W
One of: MGMT 244, BUS 352W
One of: HRM 200, MSCI 211, PSYCH 238
One of: ENBUS 102, ENBUS 302

Elective Courses

Three of: AFM 102, one other AFM course*, BET 350, BET 430, BET 450, BUS 452W, ECON 101, one other ECON course*, ENBUS 112, ENBUS 211, ENBUS 314, ENVS 201, ENVS 400, ENVS 401, PHIL 215, SPCOM 223

It is recommended that students take an introductory Economics course in Year One or Two.

Motion: Approve changes as presented.

Rationale: Remove both the asterisk after “one other ECON course” under the elective course list and MGMT 244 from the legend. ECON 344 was listed as a “one of” required course but was relabeled and renumbered to MGMT 244. Therefore, the asterisk or the restriction noted in the legend are no longer applicable.

Effective: September 2020
To: Senate Undergrad Council  
From: Brendon Larson, Associate Dean Undergraduate Studies, Faculty of Environment  
Date: October 8, 2019  
Re: Revision: Climate Change and Resource Management, Earth Systems Science, and Economy and Society Specializations

2020/2021 calendar: http://ugradcalendar.uwaterloo.ca/page/ENV-Bachelor-Environmental-Stds-Specializations

Climate Change and Resource Management

Capstone Courses:

- **GEOG 408** Earth's Future Cycles (1.0 unit)  
- **GEOG 409** Energy Balance Climatology (1.0 unit)  
- **GEOG 452** Resource Management Project (1.0 unit)  
- **GEOG 456** Transforming Canadian Resource Management (1.0 unit)  
- **GEOG 459** Energy and Sustainability (1.0 unit)  
- **GEOG 490A** Honours Thesis Preparation/GEOG 490B Honours Thesis Completion* (1.0 unit)

Earth Systems Science

Required courses:

- **GEOG 201** Fluvial Geomorphology  
- **GEOG 209** Hydroclimatology  
- **ENVS 200** Field Ecology

Elective courses:

- at least 3.0 units from List A, including at least one capstone course  
- at least 1.0 unit from List B

List A:

- **GEOG 300** Geomorphology and the Southern Ontario Environment  
- **GEOG 303** Physical Hydrology  
- **GEOG 305** Fluvial Geomorphology  
- **GEOG 304** Carbon in the Biosphere  
- **GEOG 309** Physical Climatology  
- **GEOG 320** The Cryosphere  
- **GEOG 404** Soil Ecosystem Dynamics  
- **GEOG 418** Cold Region Climates  
- **GEOG 420** Ice Sheets and Glaciers

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List A:

**GEOG 302 Geographies of Work and Employment**
- GEOG 311 Local Development in a Global Context
- GEOG 319 Economic Analyses for Regional Planning
- GEOG 336 Spaces of Citizenship
- GEOG 340 Settlements of Rural Canada
- GEOG 349 Urban Form and Internal Spatial Structure
- GEOG 411 Global and Local Dimensions of Industrial Restructuring
- GEOG 436 Feminist Economic Geography: Gender, Identities and Social Change
- GEOG 450 Changing Form and Structure of Metropolitan Canada
- GEOG 454 Retail Landscapes

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**Motion:** Approve changes to specializations as noted

**Rationale:** Changes reflect addition of new courses and applicable revisions.

**Effective:** September 2020
To: Senate Undergrad Council  
From: Brendon Larson, Associate Dean Undergraduate Studies, Faculty of Environment  
Date: October 8, 2019  
Re: Revision: Diploma in Ecological Restoration and Rehabilitation

2020/2021 Calendar: [http://ugradcalendar.uwaterloo.ca/page/ENV-Diplomas](http://ugradcalendar.uwaterloo.ca/page/ENV-Diplomas)

Diploma in Ecological Restoration and Rehabilitation

Requirements

To be awarded the Diploma, students must complete the course requirements listed below with an overall average of 70%. Students achieving an overall average of 80% in the six required and elective courses will be awarded a Diploma with Distinction.

**Motion:** Approve as presented.

**Rationale:** The proposal to revise the criteria for awarding dean's honours will include a two-tier accolade, the first of which is “with Distinction” for students graduating from a degree plan. Since a diploma is not considered a degree plan the “with distinction” for the Diploma in Ecological Restoration and Rehabilitation needs to be removed.

**Effective:** September 2020
To: Senate Undergrad Council  
From: Brendon Larson, Associate Dean Undergraduate Studies, Faculty of Environment  
Date: October 8, 2019  
Re: Revision: Audit courses


Students may request to register for Audit status (AUD) in a course taught on campus if the Faculty administering the course allows Audits. Students interested in an Audit must consult with the course instructor at the beginning of the course to ascertain what conditions are attached to the granting of an AUD. Audits must be approved by the course instructor and the student's academic plan advisor during the two week add period. Failure to satisfy the conditions of an Audit will result in the course receiving a grade of WD (Withdrawn).

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Motion: Approve removing restriction of Audit Status for on-campus courses only.

Rationale: As Environment increases its online course offerings, this revision will open the possibility for Audit Status for all courses be it on campus or online.

Effective: September 2020
To: Senate Undergrad Council  
From: Brendon Larson, Associate Dean Undergraduate Studies, Faculty of Environment  
Date: October 8, 2019  
Re: Information only: Geography and Environmental Management Honours, Geography and Aviation Honours, Geomatics Honours, and Joint Honours Geography and Environmental Management

2020/2021 calendar:
http://ugradcalendar.uwaterloo.ca/page/ENV-Geography-Environmental-Management-4-Yr-Honour

GEOG 201 Fluvial Geomorphology  
GEOG 205 Principles of Geomorphology

Effective: September 2020
Report of Mathematics Faculty Council to Senate Undergraduate Council
October 2019

Items brought to this Senate Undergraduate Council meeting have been adopted at the Mathematics Faculty Council at its meeting of 17 September 2019.

- Motion 2.1.1: to add MAV and SMAV for Data Science in the Faculty Policy section of the calendar
- Motion 2.2.1: update Statistics note to include Data Science
- Motion 2.3.1: remove note 4 from BBA/BCS calendar
- Motion 2.3.2: change note 3 from BCS/BMATH Plan combination page
- Motion 4.1.1: introduces a change to the co-op calendar for students taking multiple co-op plans
- Motion 4.1.2: introduces a separate co-op page in the undergraduate calendar
- Motion 5 is a collection of changes to courses and includes the introduction of a new course- AMATH 474

1. New Plans
   None.

2. Plan Changes
   2.1 Data Science
   Motion 2.1.1. To add the MAV and SMAV for Data Science to the ‘Major Averages for Math Students’ in the Faculty Policy section, effective September 2020, as follows:

   [Table]

<table>
<thead>
<tr>
<th>Major/Plan</th>
<th>Average(s)</th>
<th>Relevant Courses</th>
<th>Minimum required average</th>
<th>Minimum courses for MAV or SMAV</th>
</tr>
</thead>
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<td>Data Science (all plans)</td>
<td>MAV</td>
<td>As for “Computer Science” in this table</td>
<td>60%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>SMAV</td>
<td>As for “Statistics” in this table</td>
<td>65%</td>
<td>3</td>
</tr>
</tbody>
</table>

   **Rationale:** The addition of a MAV and a SMAV for both Data Science plans (BCS and BMath) ensures that students have relevant MAVs and SMAVs in computer science and statistics.

2.2 Statistics
   Motion 2.2.1. Effective September 1, 2020, to update the Statistics major’s Note to include Data Science for appropriate courses and to specify STAT 37x course substitutions do apply to Data Science majors.

   One of

   One additional 400-level STAT course
   CS 457 System Performance Evaluation
   CS 485 Statistical and Computational Foundations of Machine Learning
   CS 486 Introduction to Artificial Intelligence
   **Note:** CS 457, CS 485, and CS 486 are open only to those with a major in Computer Science (CS).

   Four additional 300- or 400-level math courses.

   At least three additional math courses for a minimum of 26 math courses.
Math Faculty Council to Senate Undergraduate Council- October 2019

Notes

1. For STAT majors, including Data Science majors, currently or previously enrolled in the following plans: Business Administration and Mathematics Double Degree, Mathematics/Business Administration, Mathematics/Financial Analysis and Risk Management, Information Technology Management, and Mathematical Optimization – Business Specialization may substitute:
   - STAT 371 for STAT 331.
   - STAT 372 for STAT 332.
   - AMATH 350 for AMATH 250.

2. For STAT majors, including Data Science majors: STAT 334 is not an acceptable substitute for STAT 330 or STAT 333; STAT 373 is not an acceptable substitute for STAT 331.

3. Business Administration and Mathematics Double Degree students may substitute BUS 362W for ENGL378/MTHEL 300.

Rationale: The notes on which CS courses can be taken by whom is unnecessary as the course descriptions specify which of them are open to Data Science majors and which are not. CS has requested that it be clarified that all substitutions allowed for Honours Statistics apply to the BMath Data Science majors also.

2.3 Computer Science

Motion 2.3.1. To remove Note 4 from BBA/BCS calendar, retroactive to previous calendars starting in 2017, as follows:

[...]

Students may elect to replace the Computer Science (BCS) with one of the following degree plans if they satisfy all the degree requirements for both the alternate degree and the double degree:
- a BCS Data Science plan,
- a BMath CS plan, or
- a BMath Data Science plan.

Rationale: The BBA/BCS program contract with the Ministry doesn’t allow students in that program to receive a BMath as their computer science degree, so BMath (CS) and BMath (Data Science) are not possible. This deletion along with the new text of Motion 2.4.3 properly ensures that Double Degree students who want to receive a BCS (Data Science) degree can. Advised by RO to make changes retroactive.

Motion 2.3.2. To change note 3 on the page “Bachelor of Computer Science and Bachelor of Mathematics Academic Plan Combinations”, retroactive to previous calendars starting in 2017, as follows:

The BMath (Data Science) and BCS (Data Science) plans cannot be combined with any other Faculty of Mathematics Honours or Joint Honours plan, except that the BCS (Data Science) can make up the BCS component of the Business Administration and Computer Science double degree program.

Rationale: The BBA/BCS program contract with the Ministry doesn’t allow students in that program to receive a BMath as their computer science degree, so BMath (CS) and BMath (Data Science) are not possible. This new text properly ensures that Double Degree students who want to receive a BCS (Data Science) degree can. Advised by RO to make changes retroactive.

3. Plan Inactivations.
   None.
4.1 Changes to Undergraduate Calendar for Students Taking Multiple Co-op Plans

Preamble (rationale): QUEST does not permit students to enroll in both co-op and non-co-op plans at the same time. Any students pursuing a stand-alone Honours co-op plan in the Faculty of Mathematics can only add other co-op Honours plans. Through this discussion, it was noted that students need to complete the co-op requirements of each plan that they are enrolled in. For example, students enrolled in the Math/Teaching plan only require 4 work terms to graduate, but could be pursuing another Honours plan that requires 5 work terms. To graduate with both plans, the student would therefore need to graduate with 5 work terms. Students only completing 4 work terms could still graduate with the Math/Teaching plan, but only if they chose not to graduate with the second Honours plan. The proposed bolded calendar text is intended to clarify these requirements for students (on pages 5-8 in this report)

Motion 4.1.1. To change the BCS/BMATH Academic Plan Combinations page and the Co-op regulations, effective September 2020, as follows:

**Bachelor of Computer Science and Bachelor of Mathematics Academic Plan Combinations**

Plans will be listed on a student’s diploma in the above order.

A BCS or BMath student’s plan must include one of the following:

- A stand-alone Math Faculty Honours plan, or
- Two Math Faculty Joint Honours plans, or
- A Joint BCS plan and a non-Math Joint Honours plan (acceptable non-Math Joint Honours plans are listed in the non-Math faculty section of the Calendar)

More plans may be added subject to the other restrictions of this section. The plan listed first on a graduating student’s diploma will dictate the student’s degree: if the first plan is a BCS plan, then the student will graduate with a BCS. If the first plan is a BMath plan, then the student will graduate with a BMath.

**Math Faculty Joint Honours Plans**

Joint honours academic plans both offered by the Math Faculty, in conjunction with the common degree requirements in Table I, require a total of 40 courses (20 units): the 10 mathematics courses in the Faculty core (outlined in Table II) plus the joint requirements of the two departments/school for a minimum of 26 mathematics courses, and at least 10 non-math courses (five units). Joint requirements for each department/school can be found in the corresponding department/school description.

**Restrictions on Multiple-Plan Combinations**

1. A stand-alone BCS plan cannot be combined with any BMath plan (including Joint Honours plans).
3. The BMath (Data Science) and BCS (Data Science) plans cannot be combined with any other Faculty of Mathematics Honours or Joint Honours plan.
4. With the exception of Mathematical Finance, which can be combined with another Actuarial Science and/or Pure Mathematics plan, no student may enrol in or graduate from two plans from the same group in the following list:
   - All plans offered by Actuarial Science
   - All plans offered by Applied Mathematics
   - All plans offered by Combinatorics and Optimization (including all Mathematical Optimization plans)
   - All plans offered by Computational Mathematics
   - All plans offered by Computer Science
   - All plans offered by Pure Mathematics
   - All plans offered by Statistics
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- All Math/Business plans other than Mathematical Economics

5. A stand-alone BCS Honours co-op plan or BMath Honours co-op plan cannot be combined with any stand-alone non-co-op Honours plan (including Joint Honours plans).

Co-op Regulations

General Regulations

- Co-operative mathematics students are expected to follow the normal academic/work-term sequence appropriate to their plan from admission through to graduation.
- Students admitted at the 1A level, with the exception of those in the Mathematics/Chartered Professional Accountancy and Bachelor of Business Administration (BBA)/Bachelor of Mathematics (BMath) Double Degree plans, will normally have eight academic terms and six work terms.
- Students may not end their sequence with a work term.
- Students’ requests to re-arrange their sequence will normally be approved if all the criteria listed on the Faculty of Mathematics Sequence Change Form are met. Students who alter their sequence without obtaining prior approval may be required to withdraw from the co-op system. It is the student’s responsibility to deal with any timetabling difficulties that may arise and to select courses for subsequent terms.

Professional Development (PD) Courses

- As specified in Table 1, co-op students are required to complete a minimum of five different Professional Development (PD) courses.
- PD 1 is required in the academic term prior to the first work term and PD 11 is required during the first work term.
- Students in the Bachelor of Mathematics in Computer Science and Bachelor of Computer Science plans must include PD 10, Professional Responsibility in Computing, as one of their PD courses.
- With the exception of PD 1, PD courses are normally taken during co-op work terms.
- Students are required to take a PD course each work term until the requirement is completed.

Work Reports

Co-op students must submit a work report following every work term until they have completed four acceptable work reports. Successful completion of PD 11 meets the requirement for a first work report.

Co-op Standing Rules

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Co-op Standing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The student is on academic probation after a full-time term for the first time, two missing or failed PD courses and one missing or failed work report.</td>
<td>Excellent co-op standing</td>
</tr>
<tr>
<td>No standing above applies, and in the most recent work term, the Employer Evaluation was Excellent or Outstanding.</td>
<td></td>
</tr>
<tr>
<td>No standing above applies.</td>
<td>Good co-op standing</td>
</tr>
</tbody>
</table>

The following table describes the implications of the standings listed above.
Co-op Standing | Implications
--- | ---
Withdraw from co-op | The student must withdraw from co-op, and will be transferred to the most closely matching regular plan for which the student is admissible.
Co-op probation | The student must meet with a co-op advisor to determine conditions necessary to remediate their co-op standing. A student who is on probation in co-op solely because of their academic standing will be placed in Good co-op standing if they return to Good or Excellent academic standing after one full-time academic term without missing or failing any PD courses or work reports. The student’s access to the co-op employment process will be blocked pending completion of remedial requirements.
Good co-op standing | Eligible to continue in co-op.
Excellent co-op standing | Eligible to continue in co-op.

Courses on a Work Term

- Co-op students on a work term are limited to one course (0.5 unit), unless they have written support from their employer to take two courses (1.0 unit). COOP, PD, and WKRPT courses are not included in these limits.

Transferring into Co-op

- Late transfers to the co-op system are considered once per term. Admission is very competitive and is a function of availability and demonstrated academic performance at the university level.
- Regular students in the Faculty of Mathematics may apply to transfer to the co-op system of study in their 1B term. To be eligible, at the time of admission to co-op, such students must have successfully completed between 4.0 and 6.0 units, including transfer credits.
- Non-co-op students from other faculties at the University of Waterloo may apply to transfer to the co-op system in the Faculty of Mathematics at the end of their 1B term, as part of the internal transfer process.

Non-co-op students external to the University of Waterloo are eligible to apply for co-op in the Faculty of Mathematics only if, at the time of admission, they have successfully completed no more than 3.0 units of math transfer credits and between 4.0 and 6.0 transfer credits overall.
- Applications to transfer to co-op from co-op students external to the University of Waterloo will be considered on a case-by-case basis.

Multiple Co-op Majors

- Students pursuing more than one stand-alone Honours co-op plan in the Faculty of Mathematics:
  - Must meet the co-op requirements associated with each plan.
  - Can count completed work terms, PD courses, and work term reports toward each stand-alone Honours co-op plans.
- Students cannot graduate with a combination of co-op and non-co-op Honours plans (see Bachelor of Computer Science and Bachelor of Mathematics Academic Plan Combinations)

5. Course Changes.
5.1 AMATH (catalog reports #98 and #96)
5.1.1. To add a new course, AMATH 474 (#98)
5.1.2. To add a one hour TST and one hour TUT component, AMATH 332/PMATH 332 (#96) - effective date of this change is May 1, 2020

5.2 CO (catalog report #98)
5.2.1. To correct pre-requisites, change anti-requisites and add a one hour TST component, CO 250
5.2.2. To inactivate CO 453

5.3 COMM (catalog report #97)
5.3.1. To add a one hour TST component, COMM 321
5.3.2. To add a one hour TUT component, COMM 431
5.3.3. To add a one hour TUT component, COMM 432

5.4 CS (catalog report #96)
5.4.1. To change anti-requisites, CS 115
5.4.2. To change anti-requisites, CS 116
5.4.3. To change anti-requisites, CS 135
5.4.4. To change anti-requisites, CS 240
5.4.5. To change anti-requisites, CS 245
5.4.6. To change anti-requisites, CS 245E
5.4.7. To change anti-requisites, CS 370
5.4.8. To change anti-requisites, CS 371/AMATH 242

5.5 MATBUS (catalog report #97)
5.5.1. To add a one hour TST component, MATBUS 470
5.5.2. To add a one hour TST component, MATBUS 471
5.5.3. To add a one hour TST component, MATBUS 472

6. Other Business.
None.
COURSE CHANGES  (for approval)

Applied Mathematics

Current Catalog Information
AMATH 242 (0.50) LAB, LEC Introduction to Computational Mathematics
A rigorous introduction to the field of computational mathematics. The focus is on
the interplay between continuous models and their solution via discrete processes.
Topics include pitfalls in computation, solution of linear systems, interpolation,
discrete Fourier transforms, and numerical integration. Applications are used as
motivation. [Note: This course may be substituted for CS 370 in any degree plan or
for prerequisite purposes; lab is not scheduled and students are expected to find
time in open hours to complete their work. Offered: W,S]
No Special Consent Required
Requisites:
Prereq: (One of CS 116, 136, 138, 146), MATH 235 or 245, 237 or 247.
Antireq: CS 335, 370, MTE 204
Cross-listed as: CS 371
Effective 01-SEP-2020
Rationale: Engineering course updates and re-examination of their curricular content
to properly assess overlap with our courses.

Current Catalog Information
AMATH 332 (0.50) LEC Applied Complex Analysis
Complex numbers, Cauchy-Riemann equations, analytic functions, conformal maps and
applications to the solution of Laplace's equation, contour integrals, Cauchy
integral formula, Taylor and Laurent expansions, residue calculus and applications.
[Note: PMATH 352 may be substituted for AMATH/PMATH 332 whenever the latter is a
requirement in an Honours plan. Offered: W,S]
No Special Consent Required
Requisites:
Prereq: MATH 237 or 247. Antireq: PHYS 365
Cross-listed as: PMATH 332
Effective 01-MAY-2020
Component Change: LEC, TST, TUT
Rationale: To add a weekly tutorial hour and midterm test slot scheduled by the
Registrar's Office. Scheduled tutorials and a midterm slot have been
requested by instructors from the Applied Mathematics department, who
deliver the course each Spring term. Apparently the only way to get these
scheduled slots is by adding the TUT and TST annotations to the official
Calendar description of the course. The Applied Mathematics department
would very much like not have to wait until the Spring 2021 term to begin
receiving these scheduled slots. Approval has been given from the
Registrar's Office to have an earlier effective date.
The tutorials will be used to facilitate weekly quizzes. The TST slot will be used for the midterm.

Computer Science - David R. Cheriton School of

Current Catalog Information

CS 115 (0.50) LAB, LEC, TST, TUT Introduction to Computer Science 1

[Note: See Note 2 above. Offered: F,W,S]

No Special Consent Required

Requisites:
Antireq: BME 121, CS 135, 137, 138, 145, CHE 121, CIVE 121, ECE 150, GENE 121, ME 101, NE 111, MSCI 121, PHYS 139, 236, SYDE 121

Effective 01-SEP-2020

Requisite Change:
Antireq: BME 121, CS 135, 137, 138, 145, CHE 121, CIVE 121, ECE 150, GENE 121, ME 101, NE 111, MSCI 121, PHYS 139, SYDE 121

Rationale:
Engineering course updates and re-examination of their curricular content to properly assess overlap with our courses.

Current Catalog Information

CS 116 (0.50) LAB, LEC, TST, TUT Introduction to Computer Science 2
This course builds on the techniques and patterns learned in CS 115 while making the transition to use of an imperative language. Generative and structural recursion. Mutation (assignment) and its role in an imperative language. Primitive types and basic I/O. Sequencing, selection, looping. Function definition and use. File and console I/O. Issues in computer science. [Offered: F,W,S]

No Special Consent Required

Requisites:
Prereq: CS 115 or 135 or 145. Antireq: CS 136, 137, 138, 146, PHYS 239

Effective 01-SEP-2020

Requisite Change:
Prereq: CS 115 or 135 or 145
Antireq: CS 136, 137, 138, 146, PHYS 236, 239, MSCI 240, NE 111

Rationale:
Engineering course updates and re-examination of their curricular content to properly assess overlap with our courses.

Current Catalog Information

CS 135 (0.50) LAB, LEC, TST, TUT Designing Functional Programs
No Special Consent Required
Requisites:

Antireq: BME 121, CS 115, 137, 138, 145, CHE 121, CIVE 121, ECE 150, GENE 121, ME 101, MSCI 121, NE 111, PHYS 236, SYDE 121

Effective 01-SEP-2020
Requisite Change:

Antireq: BME 121, CS 115, 137, 138, 145, CIVE 121, ECE 150, ME 101, MSCI 121, PHYS 236, SYDE 121

Rationale:
Engineering course updates and re-examination of their curricular content to properly assess overlap with our courses.

Current Catalog Information
CS 240 (0.50) LAB, LEC, TST, TUT Data Structures and Data Management
Introduction to widely used and effective methods of data organization, focusing on data structures, their algorithms, and the performance of these algorithms. Specific topics include priority queues, sorting, dictionaries, data structures for text processing. [Note: Enrolment is restricted; see Note 1 above. Lab is not scheduled and students are expected to find time in open hours to complete their work. Offered: F,W,S]

No Special Consent Required
Requisites:

Prereq: (CS 245 or SE 212), (one of CS 241, 246, 247), (one of STAT 206, 230, 240); Computer Science and BMath (Data Science) students only.
Antireq: BME 122, CS 234, ECE 250, MSCI 240, MTE 140, SYDE 223

Effective 01-SEP-2020
Requisite Change:

Prereq: (CS 245 or SE 212), (one of CS 241, 246, 247), (one of STAT 206, 230, 240); Computer Science and BMath (Data Science) students only.
Antireq: BME 122, CS 234, ECE 250, MTE 140, SYDE 223

Rationale:
Engineering course updates and re-examination of their curricular content to properly assess overlap with our courses.

Current Catalog Information
CS 245 (0.50) LEC, TST, TUT Logic and Computation
Propositional and predicate logic. Soundness and completeness and their implications. Unprovability of formulae in certain systems. Undecidability of problems in computation, including the halting problem. Reasoning about programs. Correctness proofs for both recursive and iterative program constructions. [Note: Enrolment is restricted; see Note 1 above. Offered: F,W,S]

No Special Consent Required
Requisites:

Prereq: (One of CS 136, 138, 146), MATH 135; Honours Mathematics students only. Antireq: PMATH 330, SE 212

Effective 01-SEP-2020
Requisite Change:

Prereq: (One of CS 136, 138, 146), MATH 135; Honours Mathematics students only. Antireq: PMATH 330, ECE 208, SE 212

Rationale:
Engineering course updates and re-examination of their curricular content to properly assess overlap with our courses.

Current Catalog Information
CS 245E (0.50)  LEC, TST, TUT Logic and Computation (Enriched)
Enriched version of CS 245. [Note: See notes 1 and 9 above. CS 245E may be
substituted for CS 245 wherever the latter is a requirement. Enrolment is restricted.
Offered: As permitted by demand and available resources.]
No Special Consent Required
Requisites:
Prereq: A grade of 85% or higher in one of CS 136 or 146; Honours
Mathematics students only. Antireq: SYDE 322
Effective 01-SEP-2020
Requisite Change:
Prereq: A grade of 85% or higher in one of CS 136 or 146; Honours
Mathematics students only. Antireq: ECE 208, PMATH 330, and SE 212
Rationale:
Engineering course updates and re-examination of their curricular content
to properly assess overlap with our courses.

Current Catalog Information
CS 370 (0.50)  LAB, LEC, TST Numerical Computation
Principles and practices of basic numerical computation as a key aspect of scientific
computation. Visualization of results. Approximation by splines, fast Fourier
transforms, solution of linear and nonlinear equations, differential equations,
floating point number systems, error, stability. Presented in the context of specific
applications to image processing, analysis of data, scientific modeling. [Note: Lab
is not scheduled and students are expected to find time in open hours to complete
their work. Offered: F,W,S]
No Special Consent Required
Requisites:
Prereq: (One of MATH 118, 119, 128, 138, 148), (one of MATH 106, 114, 115,
136, 146), (one of CS 231, 234, 241, 246). Antireq: AMATH 242/CS 371, CS
335, MTE 204
Effective 01-SEP-2020
Requisite Change:
Prereq: (One of MATH 118, 119, 128, 138, 148), (one of MATH 106, 114, 115,
136, 146), (one of CS 231, 234, 241, 246). Antireq: AMATH 242/CS 371, CHE
121, CIVE 121, CS 335, ECE 204, MTE 204
Rationale:
Engineering course updates and re-examination of their curricular content
to properly assess overlap with our courses.

Current Catalog Information
CS 371 (0.50)  LAB, LEC Introduction to Computational Mathematics
A rigorous introduction to the field of computational mathematics. The focus is on
the interplay between continuous models and their solution via discrete processes.
Topics include pitfalls in computation, solution of linear systems, interpolation,
discrete Fourier transforms, and numerical integration. Applications are used as
motivation. [Note: This course may be substituted for CS 370 in any degree plan or
for prerequisite purposes; lab is not scheduled and students are expected to find
time in open hours to complete their work. Offered: W,S]
No Special Consent Required
Requisites:
Prereq: (One of CS 116, 136, 138, 146), MATH 235 or 245, 237 or 247.
Antireq: CS 335, 370, MTE 204
Cross-listed as: AMATH 242

Effective 01-SEP-2020
Requisite Change:
Prereq: (One of CS 116, 136, 138, 146), MATH 235 or 245, 237 or 247.
Antireq: CS 335, 370, ECE 204, MTE 204
Rationale:
Engineering course updates and re-examination of their curricular content to properly assess overlap with our courses.

Pure Mathematics

Current Catalog Information
PMATH 332 (0.50) LEC Applied Complex Analysis
Complex numbers, Cauchy-Riemann equations, analytic functions, conformal maps and applications to the solution of Laplace's equation, contour integrals, Cauchy integral formula, Taylor and Laurent expansions, residue calculus and applications.
[Note: PMATH 352 may be substituted for AMATH/PMATH 332 whenever the latter is a requirement in an Honours plan. Offered: W,S]
No Special Consent Required
Requisites:
Prereq: MATH 237 or 247. Antireq: PHYS 365
Cross-listed as:
AMATH 332

Effective 01-MAY-2020
Component Change: LEC, TST, TUT
Rationale:
To add a weekly tutorial hour and midterm test slot scheduled by the Registrar's Office. Scheduled tutorials and a midterm slot have been requested by instructors from the Applied Mathematics department, who deliver the course each Spring term. Apparently the only way to get these scheduled slots is by adding the TUT and TST annotations to the official Calendar description of the course. The Applied Mathematics department would very much like not have to wait until the Spring 2021 term to begin receiving these scheduled slots. Approval has been given from the Registrar's Office to have an earlier effective date.

The tutorials will be used to facilitate weekly quizzes. The TST slot will be used for the midterm.
COURSE CHANGES  (for approval)

Dean of Mathematics

Current Catalog Information

COMM 321 (0.50)  LEC  Intermediate Accounting for Finance

This intermediate level accounting course will focus on the usage of financial information from a management perspective.

No Special Consent Required

Requisites : Prereq: AFM 101 or BUS 227W; Mathematics/Financial Analysis and Risk Management students only. Antireq: AFM 291, BUS 387W

Effective  01-SEP-2020

Component Change:  LEC, TST

Rationale : In-class midterms have proved problematic, and a test slot will solve certain logistical difficulties.

Current Catalog Information

COMM 431 (0.50)  LEC  Project Management

This course will introduce students to approaches, techniques and terminology used in project management. In particular, students will learn project planning principles, product and process metrics, people and organizational issues, task allocation and scheduling, monitoring and control, change management, and methods for cost estimation and risk assessment. Students will also be introduced to current project management tools, and will manage their own term project.

No Special Consent Required

Requisites : Prereq: AFM 102, MSCI 211; Level at least 3A

Effective  01-SEP-2020

Component Change:  LEC, TUT

Rationale : These courses in electronic commerce and project management will benefit from a tutorial section for additional activities.

Current Catalog Information

COMM 432 (0.50)  LEC  Electronic Business

This course will introduce students to approaches, techniques and terminology used in electronic business. Students will also study issues in disciplines related to electronic business. They will review a number of sites and identify efficient e-commerce analysis, design and development techniques. Students will be introduced to current electronic business tools and standards, and will construct their own simple electronic business site.

No Special Consent Required

Requisites : Prereq: BUS 352W, CS 330 or 490; Level at least 3A. Antireq: AFM 443

Effective  01-SEP-2020
Component Change: LEC, TUT
Rationale: These courses in electronic commerce and project management will benefit from a tutorial section for additional activities.

**Current Catalog Information**

**MATBUS 470 (0.50) LAB, LEC**

Derivatives
No Special Consent Required
Requisites:
Prereq: (One of AFM 372/ACTSC 391, ACTSC 371, BUS 393W), (STAT 334 or (STAT 330 and 333)). Antireq: AFM 322/474, ACTSC/STAT 446, BUS 423W, ECON 372

Effective 01-SEP-2020
Component Change: LAB, LEC, TST
Rationale: Although we often schedule midterms in class, we wish to have the option to schedule midterms during a test slot.

**Current Catalog Information**

**MATBUS 471 (0.50) LAB, LEC**

Fixed Income Securities
No Special Consent Required
Requisites:
Prereq: ACTSC 231 and (ACTSC 372 or BUS 393W) or AFM 372/ACTSC 391; Business/Math double degree, Math/Accounting, or Math/Financial Analysis and Risk Management students only. Antireq: AFM 425/475, BUS 449W

Effective 01-SEP-2020
Component Change: LAB, LEC, TST
Rationale: Although we often schedule midterms in class, we wish to have the option to schedule midterms during a test slot.

**Current Catalog Information**

**MATBUS 472 (0.50) LAB, LEC**

Risk Management
No Special Consent Required
Requisites:

Effective 01-SEP-2020
Component Change: LAB, LEC, TST
Rationale: Although we often schedule midterms in class, we wish to have the option to schedule midterms during a test slot.

End of Report
NEW COURSES  (for approval)

Applied Mathematics

Effective 01-SEP-2020

AMATH 474 (0.50) LEC, TUT Quantum Theory 3: Quantum Information and Foundations
Theory of correlations and entanglement; theory of quantum channels, detectors; the measurement problem, in quantum mechanics; phase space formulation of quantum mechanics; entanglement in infinite dimensional quantum systems; introduction to open quantum systems; and exploration of current research directions in quantum information. [Offered: W]

Requisites: Prereq: AMATH 473/PHYS 454; Level at least 4A in Mathematics or Science
Rationale: To add new course. This course is structured to introduce senior undergraduates in Applied Mathematics and Mathematical Physics to some of the state of the art topics in fundamental quantum theory and quantum information. The course introduces the basics of entanglement theory, continuous variables in quantum mechanics, and open quantum systems and ends with a connection of the contents with current research avenues both in theoretical and applied quantum information theory. The topics are designed so that the material will be covered in 36 lecture hours. There is no overlap between this course and other quantum information courses.

COURSE CHANGES  (for approval)

Combinatorics & Optimization

Current Catalog Information

CO 250 (0.50) LEC Introduction to Optimization
A broad introduction to the field of optimization, discussing applications and solution techniques. Mathematical models for real life applications; algorithms; aspects of computational complexity; geometry; linear programming duality, focusing on the development of algorithms. [Offered: F,W,S]

Requisites: Prereq: One of MATH 106 with a grade of at least 70%, MATH 115, 136, 146; Cumulative overall average of at least 60%. Antireq: CO 227, 352, 255/355
Rationale: Corrects an omission in previous prerequisites where students with MATH114
were not allowed to take the course. Also, ensures that minimum grade requirements are applied to all non-math versions of MATH136.
Change in Antireq is to reflect the fact that CO355 has switched to CO255 since 2010/11, and CO352 has also not been in our calendar since 2011/12. Addition of TST slot is for the online version of the course, though calendar does not differentiate the two.

**COURSE INACTIVATIONS** (for approval)

Effective  01-SEP-2020  
CO  453  ( 0.50 )  Network Design  
Rationale :  This course has not been taught for quite some time.
SCIENCE FACULTY COUNCIL

REPORT TO SENATE UNDERGRADUATE COUNCIL

FACULTY OF SCIENCE SUBMISSION- for October 2019 SUC

For approval and inclusion in the 2020-2021 Undergraduate Calendar

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A. COURSE CHANGES (see report 73)
   i. New Courses – none
   ii. Changes to Existing Courses
      a) Aviation
         AVIA 310, 416 (was 315), 417 (was 320), 474, and 475
   iii. Inactivated Courses - none

B. NEW PROGRAMS/PLANS - none

C. CHANGES TO PROGRAMS/PLANS - none

D. NEW REGULATIONS AND PROCEDURES - none

E. CHANGES TO REGULATIONS AND PROCEDURES - none

F. INACTIVATIONS OF REGULATIONS AND PROCEDURES - none
COURSE CHANGES  (for approval)

Interdisciplinary Studies

Current Catalog Information
AVIA  310 (0.50) LAB, LEC Human Factors in Aviation
   A case study-influenced course emphasizing the need for pilots to recognize and
   improve interpersonal skills for problem solving and conflict management. Components
   introduce Crew Resource Management (CRM), the human component of the human-technology
   interface, and the cumulative act effect.
   No Special Consent Required
   Requisites : Prereq: Level at least 2A Science and Aviation or Geography and Aviation
               students only
Effective  01-SEP-2020
Description Change: An exploration of aviation non-technical skills and their impact on
   aviation safety and operational performance. Components explore workload,
   management, situational awareness, decision-making, and crew coordination.
Requisite Change : Prereq: AVIA 100; Level at least 2A
Rationale : AVIA 100 is added as a prerequisite to support Geography and Environmental
   Management and Geomatics students pursuing the Aviation Specialization
   (effective September 2020), in addition to Geography and Aviation and
   Science and Aviation students enrolling in this course. The description is
   updated to better align with the course structure and content.

Current Catalog Information
AVIA  315 (0.50) SEM Aviation Sustainability
   An exploration of how sustainability is sought within the international aviation
   industry. The course takes a cross-sectional approach to aviation, exploring
   sustainability within the various sectors that make up the air transport system
   (e.g., air law, aircraft, operations, navigation, airports, and safety). Both the
   positive and negative impacts of aviation upon the sustainable development goals will
   be analyzed through reviewing case studies and industry practices. [Note: Prior
   completion of AVIA 100 is recommended.]
   Instructor Consent Required
   Cross-listed as: GEOG 315
Effective  01-SEP-2020
Subject/Catalog Nbr Change: AVIA  416
Unit Change: (1.00)
Component Change: PRJ, SEM
Description Change: An exploration of how sustainability is sought within the international
   aviation industry. The course takes a cross-sectional approach to aviation,
   exploring sustainability within the various sectors that make up the air
transport system (e.g., air law, aircraft, operations, navigation, airports, and safety). Both the positive and negative impacts of aviation upon the sustainable development goals will be analyzed through reviewing case studies and industry practices. This course includes significant student project teamwork. [Note: Formerly AVIA/GEOG 315]

Consent Change:  No Special Consent Required

Requisite Change:  Prereq: AVIA 100; Level at least 2A. Antireq: GEOG 474/AVIA 374 001 W18, GEOG 315/AVIA 315

Rationale:  This course is being redeveloped as a capstone course for the Aviation Specialization. Students are required to work on problem statements (of real-world challenges) throughout the semester and present their final solutions to a panel of industry experts at the end of term; therefore, a PRJ component has been added. The course number is changed from a 300-level to a 400-level number, and the unit is increased to 1.0 to reflect the amount of work required for the course. Instructor consent is removed, and requisites are updated (formerly: Prereq: Level at least 2A. Antireq: GEOG 474 001 W18).

Current Catalog Information

AVIA 320  (0.50)  LEC, TUT  Aviation Safety

This course is an advanced exploration of how aviation safety is managed at the organizational level. Content will include explorations of pilot threat and error management, safety management systems (including risk analysis and hazard identification), and safety audits. The focal point of the course is on understanding the nature and causation of accidents. [Offered: W]

No Special Consent Required

Effective 01-SEP-2020

Subject/Catalog Nbr Change:  AVIA 417

Component Change:  PRJ, SEM

Description Change:  This course is an advanced exploration of how aviation safety is managed at the organizational level. Content will include explorations of pilot threat and error management, safety management systems (including risk analysis and hazard identification), and safety audits. The focal point of the course is on understanding the nature and causation of accidents. This course includes significant student project teamwork. [Offered: W]

Requisite Change:  Prereq: AVIA 310; Geography and Aviation or Science and Aviation students only

Rationale:  This course has become a capstone experience for students within the Geography & Aviation and Science & Aviation programs. A significant amount of independent research and a total of four presentations and written assignments are required as groups work through solutions to industry safety issues. Student groups are expected to draw from their previous coursework and flight experience when crafting their solution. The course number is changed from a 300-level to a 400-level course to reflect that this course provides a culminating experience and fits best at the end of the program. The component type is change from LEC and TUT to SEM and PRJ
to reflect the work required within the course. This course remains limited to those pursuing the pilot-focused aviation programs.

Current Catalog Information

AVIA 474 (0.50) LEC, SEM, TUT Special Topics in Aviation
An advanced special topics course offered in a particular branch of aviation, subject to availability of instructor.
Department Consent Required
Requisites: Prereq: Honours Aviation students

Effective 01-SEP-2020
Requisite Change: Prereq: Level at least 2A Honours Aviation or Aviation Specialization students
Rationale: Prerequisites are updated to allow access to students pursing the Aviation Specialization.

Current Catalog Information

AVIA 475 (0.50) RDG Independent Studies of Selected Topics
Individual study of special topics not covered in other aviation courses. Students will not be given permission to register for this course until a faculty member has agreed to supervise the study and the student has developed a brief outline of study to be approved by the Director of Aviation.
Department Consent Required
Requisites: Prereq: Level at least 3A Honours Aviation

Effective 01-SEP-2020
Requisite Change: Prereq: Level at least 3A Honours Aviation or Aviation Specialization students
Rationale: Prerequisites are updated to allow access to students pursuing the Aviation Specialization.
TO: Rebecca Wickens, Assistant University Secretary, Secretariat

FROM: Paul Fieguth, Acting Associate Dean, U/G Studies, Faculty of Engineering
     Benoit Charbonneau, Associate Dean, U/G Studies, Faculty of Mathematics

SUBJECT: Items for Approval at October 8, 2019 Senate Undergraduate Council

The following items were approved by the Faculty of Engineering Undergraduate Studies Committee at their meeting on June 28, 2019, by Engineering Faculty Council on September 17, 2019, by the Mathematics Undergraduate Affairs Committee on June 24, 2019 and by the Mathematics Faculty Council on September 17, 2019. We are seeking approval for these items from Senate Undergraduate Council on October 8, 2019.

Attachment #1 contains the modified portion of the Software Engineering program description.

[All changes are effective September 2020, or as otherwise noted.]

NOTE: ITEMS WHICH DO NOT REQUIRE SENATE U/G COUNCIL APPROVAL ARE SHOWN AS SMALL CAPS IN ITALICS, WITH WAVE UNDERLINE. THESE ITEMS RECEIVE FINAL APPROVAL AT ENGINEERING FACULTY COUNCIL AND MATH FACULTY COUNCIL AND ARE FORWARDED TO SENATE U/G COUNCIL FOR INFORMATION AND IMPLEMENTATION.

Background and Motivation

i) **CHANGE OPTIONS IN THE LIST FROM COMPUTER SCIENCE TO SPECIALIZATIONS. THESE INCLUDE ARTIFICIAL INTELLIGENCE, BUSINESS, COMPUTATIONAL FINE ARTS AND HUMAN-COMPUTER INTERACTION. THIS IS A HOUSEKEEPING CHANGE INITIATED BY COMPUTER SCIENCE.** [Note: Effective September 2019.]

ii) Clarify opportunities for Software Engineering students by adding more detailed information regarding their eligibility for Options and Specializations.

iii) Reduce the number of open electives from three to two. This reduces the required course load in 3A and 3B as outlined in revisions to Notes 1 and 2. This change affects students entering in September 2020.

iv) ECE has removed ECE 418 from its technical elective list due to significant overlap in content with ECE 358. This requires a change with SE removing the course from its list of Three Technical Advanced Electives.

v) Provide additional scheduling flexibility by allowing students to take CHEM 120 instead of CHE 102. CHE 102 is treated as an elective for the purpose of reduced load, and may be taken before or after 2A. See new note (7).

vi) Add new course: PD19, Tactics for Workplace Success. Require PD19 and PD20 in the first two work terms. Remove PD21 Engineering Workplace Skills II.

Paul Fieguth
Acting Associate Dean, U/G Studies
Faculty of Engineering

B. Charbonneau
Associate Dean, U/G Studies
Faculty of Mathematics
Software Engineering

Options, Specializations, Minors, and Joint Honours

Software Engineering students are considered to be 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, and include:

- **Artificial Intelligence Option Specialization** (from Computer Science) or **Artificial Intelligence Option** (from Engineering)
- **Business Option Specialization** (from Computer Science)
- **Cognitive Science Minor** (a university-wide minor)
- **Computational Fine Arts Option Specialization** (from Computer Science)
- **Human-Computer Interaction Option Specialization** (from Computer Science)
- **Entrepreneurship Option** (from Engineering)
- **Management Sciences Option** (from Engineering)

**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. The full list of Computer Science specializations may be found in the Computer Science Specializations section of the Calendar, while the full list of Engineering options may be found at Options, Specializations and Electives for Engineering Students.**

The following Joint Honours Mathematics 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 II Faculty Core Courses requirements in the Degree Requirements for all Math students. These students are still required to fulfill 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.
Academic Curriculum

Key for next table

<table>
<thead>
<tr>
<th>Abbreviation/ Symbol</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>*</td>
<td>One hour seminar per week</td>
</tr>
<tr>
<td>**</td>
<td>Laboratory is not scheduled and students are expected to find time in open hours to complete their work</td>
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<tr>
<td>+</td>
<td>Number of contact hours for the tutorial or laboratory are unknown; there may be more components than the class (LEC) section</td>
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<table>
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<tr>
<th>Cls</th>
<th>Tut</th>
<th>Lab</th>
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<tr>
<td>Class</td>
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<tr>
<td>Tutorial</td>
<td></td>
<td></td>
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<tr>
<td>Laboratory</td>
<td></td>
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</tr>
<tr>
<td>0 - 9</td>
<td>Number of hours for Class, Tutorial, Laboratory</td>
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The term by term academic component of the curriculum is as follows:

<table>
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<th>Term</th>
<th>Course and Title</th>
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<th>Tut</th>
<th>Lab</th>
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<td>CS 137 Programming Principles</td>
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<td>ECE 105 Classical Mechanics</td>
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<tr>
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<td>MATH 115 Linear Algebra for Engineering</td>
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<tr>
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<td>MATH 117 Calculus 1 for Engineering</td>
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<td>0</td>
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<tr>
<td></td>
<td>MATH 135 Algebra for Honours Mathematics</td>
<td>3</td>
<td>1</td>
<td>0</td>
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<tr>
<td></td>
<td>SE 101 Introduction to Methods of Software Engineering*</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>1B Winter</td>
<td>SE 102 Seminar</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>CS 138 Introduction to Data Abstraction and Implementation</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>ECE 106 Electricity and Magnetism</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
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<tr>
<td></td>
<td>ECE 124 Digital Circuits and Systems</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
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<tr>
<td></td>
<td>ECE 140 Linear Circuits</td>
<td>3</td>
<td>2</td>
<td>1.25</td>
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<td></td>
<td>MATH 119 Calculus 2 for Engineering</td>
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<td>2A Fall</td>
<td>SE 201 Seminar</td>
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<td>CHE 102 Chemistry for Engineers (see note 7)</td>
<td>3</td>
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<tr>
<td></td>
<td>CS 241 Foundations of Sequential Programs</td>
<td>3</td>
<td>1</td>
<td>2</td>
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<tr>
<td></td>
<td>ECE 222 Digital Computers</td>
<td>3</td>
<td>1</td>
<td>1.25</td>
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<tr>
<td></td>
<td>SE 212 Logic and Computation</td>
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<tr>
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<td>STAT 206 Statistics for Software Engineering (see note 5)</td>
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<td></td>
<td>Communication Elective (see note 6)</td>
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<tr>
<td>2B Spring</td>
<td>SE 202 Seminar</td>
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<tr>
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<td>CS 240 Data Structures and Data Management</td>
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<td>Course Title</td>
<td>Credit</td>
<td>Year 1</td>
<td>Year 2</td>
</tr>
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<td>-----------------------------------------------------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
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<tr>
<td>CS 247</td>
<td>Software Engineering Principles **</td>
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<tr>
<td>CS 348</td>
<td>Introduction to Database Management</td>
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<td>ECE 192</td>
<td>Engineering Economics and Impact on Society</td>
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<td>MATH 239</td>
<td>Introduction to Combinatorics</td>
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<td>0</td>
</tr>
<tr>
<td>Elective (see note 1)</td>
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<tr>
<td>WKRPT 200</td>
<td>Work-term Report</td>
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<tr>
<td>SE 301</td>
<td>Seminar</td>
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<tr>
<td>CS 341</td>
<td>Algorithms</td>
<td>3</td>
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<td>3</td>
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<tr>
<td>CS 349</td>
<td>User Interfaces **</td>
<td>3</td>
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<tr>
<td>MATH 213</td>
<td>Signals, Systems, and Differential Equations</td>
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<tr>
<td>SE 350</td>
<td>Operating Systems</td>
<td>3</td>
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<td>SE 465</td>
<td>Software Testing and Quality Assurance **</td>
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<td>3</td>
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<td>Elective (see notes 1 and 2)</td>
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<td>Concurrent and Parallel Programming</td>
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<td>ECE 358</td>
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<td>SE 380</td>
<td>Introduction to Feedback Control</td>
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<tr>
<td>SE 390</td>
<td>Design Project Planning **</td>
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<td>SE 464</td>
<td>Software Design and Architectures **</td>
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<td>3</td>
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<td>Elective (see notes 1 and 2)</td>
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<tr>
<td>WKRPT 300</td>
<td>Work-term Report</td>
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<tr>
<td>SE 401</td>
<td>Seminar</td>
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<td>0</td>
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<tr>
<td>SE 463</td>
<td>Software Requirements Specification and Analysis **</td>
<td>3</td>
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</tr>
<tr>
<td>SE 490</td>
<td>Design Project 1 **</td>
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<tr>
<td>Three Electives (see notes 1 and 2)</td>
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<td>WKRPT 400</td>
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<td>Four Electives (see notes 1 and 2)</td>
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</tbody>
</table>

**Three Advanced Technical Electives (ATE)**

The advanced technical electives comprise fourth-year course offerings in CS or ECE. Students are advised to plan ahead when selecting ATEs. Most ATEs are not offered every term, and some ATEs have other ATEs as prerequisites. Other courses may be approved by the academic advisors.

One of the following CS courses (CS List):

- **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 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

One of the following ECE courses (ECE list):

ECE 409 Cryptography and System Security
ECE 416 Advanced Topics in Networking
ECE 417 Image Processing
ECE 418 Communications Networks
ECE 423 Embedded Computer Systems
ECE 429 Computer Architecture
ECE 454 Distributed Computing
ECE 455 Embedded Software
ECE 457A Cooperative and Adaptive Algorithms
ECE 457B Fundamentals of Computational Intelligence
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

One additional course from the CS and ECE lists above

Two Science Electives (SCE)

Normally these courses are in the natural sciences, chosen from the list below. Alternate courses may be chosen in consultation with the SE academic advisors.

Science Elective Courses:
BIOL 110, BIOL 120, (BIOL 130 and BIOL 130L), BIOL 150, BIOL 165, BIOL 239, BIOL 240, BIOL 273, CHE 161, (CHEM 262 and CHEM 262L), EARTH 121, EARTH 122, PHYS 124, PHYS 175, PHYS 234, PHYS 263, PHYS 275, PHYS 334, PHYS 375, SCI 238, SCI 250

Three Linkage Electives (LE)

At least one from each of the areas of Societal Issues, Humanities and Social Sciences, and Communications, 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 course on Communication:
ENGL 109, ENGL 129R/EMLS 129R, EMLS 101R, EMLS 102R, SPCOM 100, SPCOM 223

One additional course on Humanities and Social Sciences:
Complementary Studies Elective List C

Notes

1. There are ++ 10 electives. As detailed above, these electives must include three advanced technical electives, two science electives, and three linkage electives. For their remaining three 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 and beyond 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 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.

Five Professional Development (PD) Courses

Five professional development 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 20 - PD 19 and PD 21 - 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 student have three core PD courses (PD 10, PD 19, and PD 20) and two elective PD 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.
Memorandum

To: Senate Undergraduate Council
From: University Registrar
Date: September 25, 2019
Re: Reading Week – For information

At the May 15, 2019 SUC meeting, the committee approved the following text change, effective September 1, 2020:

Reading Week
Reading weeks occur in the fall and winter terms; they start with the Saturday before the statutory public holidays of Thanksgiving Day and Family Day and end on the following Sunday.

We would like to make this change effective September 1, 2019 instead (amending the 2019-20 Undergraduate Calendar) since the 4-day reading week pilot is beginning in 2019 (next week) and because the intention has always been that students shouldn’t be expected to complete assignments, etc. during the weekends on either side of the break. Having this statement available during the first year of the pilot will be helpful, especially to clarify communications surrounding the pilot.
Memorandum

To: Rebecca Wickens, Associate University Secretary
CC: Chris Read, Associate Provost, Students
    Ian Rowlands, Associate Vice-President, International
From: Heather Westmorland, Acting Director, Student Success Office (SSO)
      Sacha Geer, Manager, International Mobility and Intercultural Learning, SSO
      Sandra López-Rocha, Intercultural Learning Specialist, SSO
Date: September 23, 2019

RE: Amendments to the Global Experience Certificate’s Global Studies course list

Staff responsible for the Global Experience Certificate (GEC) carried out a comprehensive and systematic assessment of the courses listed in the UG calendar to identify those that may count towards the certificate’s 0.5 Global Studies credit unit requirement. This was necessary, as the existing list has not been fully updated since it was published in the 2012-2013 UG Calendar and it currently fails to incorporate courses across faculties that are relevant to the certificate. In addition, students enrolled in the GEC have proposed to count, towards the certificate requirements, courses they have included in their own plans that are consistent with GEC goals. As such, the objectives behind the reassessment and proposed updating of the current list of Global Studies courses were a) to revisit the existing (outdated) list including 41 courses across three faculties, and b) to assess and respond to student interest in counting other existing courses towards the Global Studies course requirement.

The process involved the following:

• Reading the descriptions of all courses listed across faculties in the 2019-2020 UG Calendar.
• Reviewing SUC minutes from meetings taking place towards the end of 2017 to the most recent ones to identify courses that had been amended or would be discontinued in the 2020-2021 UG Calendar.
• Using a framework developed by the Intercultural Learning Specialist to determine a course’s relevance to the certificate, which is based on three student-learning outcomes achieved through course content, assignments, or activities:
  a) Global Perspective: Ability to develop and discuss a multi-perspective analysis of contemporary issues of a culture or region involving local, global, international, and intercultural problems or tendencies.
  b) Global Awareness: Acquired knowledge of the interconnectedness of contemporary issues, trends, and systems; ability to demonstrate knowledge and understanding of such elements involving local, global, international, and intercultural contexts.
  c) Global Engagement: Ability to address contemporary local, global, international, and intercultural issues; students have the opportunity to and are able to demonstrate willingness to engage ethically in such contexts.
• Creating an initial list, which encompassed over 300 courses across faculties (AHS, ARTS, and ENV; SCI, ENG and MATH appeared limited in courses reflecting the GEC’s framework). If two courses
were listed and one was a prerequisite, the subsequent course was removed, allowing the list to be reduced to 158 courses.

- Preparing faculty-specific documents for consultation summarizing the project goals, the course selection criteria, and the new proposed list of courses. The documents were shared with Associate Deans UG and the relevant Department Chairs (AHS, ARTS, ENV, SCI), all of whom provided support for the project and insights into the courses proposed, with the help of the Faculty Relations Managers working with the Student Success Office. Sharing the documents served a three-fold purpose:
  a) to engage the various faculties and seek confirmation that the courses’ content is indeed consistent with the GEC framework;
  b) to ensure that the courses would be listed in the 2020-2021 UG calendar;
  c) to discuss any concerns regarding the removal of some of the original 41 courses (in the current iteration of the GEC’s Global Studies course list) primarily on account of not directly addressing the student-learning outcomes in the GEC’s framework.

The consultation yielded positive results; in several instances, faculty members suggested other courses for inclusion or deletion, which was followed up. In the specific cases where a course from the original list had not been included in the new version of the list, the action was discussed with the relevant department and an agreement was reached in each instance. The outcome of the consultation and relevant amendments translated into 27 additions, for a total of 185 courses.

Observations
1) It is not anticipated that listing particular courses would drive significant numbers of additional students to these newly added courses, but rather allow students already taking these courses to count them towards the GEC’s Global Studies course requirement (0.5 credit).

2) The 2019-2020 UG calendar includes a note informing students they may submit a request for approval from the GEC should they wish to use a course other than those specified for their Global Studies credit milestone. This note is intended to remain included in the 2020-2021 UG Calendar and will allow for some discretion on the part of the Intercultural Learning Specialist to review a course syllabus and the student’s intended work against the framework outlined above to see whether it may fit.

3) Students enrolled in the GEC prior to 2020-2021 who may be planning to use a course, which will be removed from the 2019-2020 UG Calendar, for their Global Studies credit milestone will not be penalized. We will adhere to the course list from the academic calendar at the year of their enrollment with the GEC. Students who are already enrolled prior to the 2020-2021 year will be able to use the process outlined in number 2 above to earn credit for a course listed in the 2020-2021 UG Calendar.

Summary of Recommendations to be approved by Senate:
1) to substitute the current 2019-2020 Global Studies Course list (41 courses) with an updated and expanded list including 185 courses. The proposed list has an effective date of September 1, 2020.

Attached
1) Proposed list of courses for the 2020-2021 UG calendar.
Proposed list of courses for the 2020-2021 UG calendar (effective date: September 1, 2020)
Total of 185 courses across three faculties

NOTE: There are 26 courses carried over from the GEC’s Global Studies course list in the 2019-2020 UG calendar, they appear in regular font; the 15 course deletions from the same list appear with a strikethrough; the 159 additions have been bolded and underlined. Cross-listed courses have been counted once, but are listed under both departments for clarity, with the understanding that this would appear differently in the published calendar.

### AHS

<table>
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<tr>
<th>Department</th>
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<tbody>
<tr>
<td>Health Studies</td>
<td>• HLTH 260 Social Determinants of Health <em>(Cross-listed with GSJ 260)</em></td>
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<td>• HLTH 401 Global Health <em>(Cross-listed with GSJ 401)</em></td>
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<td>• HLTH 412 Comparative Health Systems</td>
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<td>Recreation and Leisure Studies</td>
<td>• REC 383 Tourism Impacts - International Perspectives <em>(Cross-listed with GEOG 323)</em></td>
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### ARTS

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<td>Accounting and Financial Management</td>
<td>• AFM 121 Introduction to Global Financial Markets</td>
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<td></td>
<td>• AFM 434 Governance and Enterprise Risk Management for Global Organizations</td>
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<td>• ANTH 202 Social and Cultural Anthropology</td>
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<td>• ANTH 221 Language and Society <em>(Cross-listed with GSJ 221)</em></td>
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<td>• ANTH 233 Inuit Cultures</td>
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<td>• ANTH 272 Issues in Contemporary Indigenous Communities in Canada <em>(Cross-listed with INDG 272)</em></td>
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<td>• ANTH 347 Medical Anthropology</td>
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<td>• ANTH 381 Anthropology of South Asia</td>
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<td>• ANTH 382 Anthropology of Contemporary China</td>
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<td>• ANTH 430 Science as Practice and Culture <em>(Cross-listed with SOC 431)</em></td>
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<td>• ANTH 447 Global Health and Medical Anthropology</td>
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<td>• ANTH 465 Borders, Boundaries, and Crossings</td>
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<td>• APPLS 301 Language, Culture, and Identity <em>(Cross-listed with GER 301)</em></td>
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<td>• ARTS 122 Quest for Meaning in the Modern World</td>
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<td>• ARBUS 301 International Business <em>(Cross-listed with AFM 333)</em></td>
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<td>Canadian Studies</td>
<td>• CDNST 201 The Indigenous Experience in Canada <em>(Cross-listed with INDG 201)</em></td>
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| Cultural Identities |  • CI 100 Cultural Identities Today  
|                    |  • CI 200 Transcultural Studies (Cross-listed with GER 200)  
|                    |  • CI 250 Truth - Reconciliation – Story  
|                    |  • CI 300 Theories of Cultural Identities  
| Dutch              |  • DUTCH 271 Dutch Culture and Society  
| East Asia          |  • EASIA 120R Monsters and Magic in Japanese Popular Culture (Cross-listed with RS 123)  
|                    |  • EASIA 202R Chinese Culture and Society  
|                    |  • EASIA 203R Japanese Culture and Society  
|                    |  • EASIA 204R Korean Culture and Society  
|                    |  • EASIA 206R Japanese Religions (Cross-listed with RS 206)  
|                    |  • EASIA 220R The History of East Asian Communities in Canada (Cross-listed with HIST 231R)  
|                    |  • EASIA 275R Religion and Japanese Film (Cross-listed with RS 275)  
|                    |  • EASIA 277R International Relations of East Asia  
|                    |  • EASIA 300R Politics and Diplomacy of Contemporary Japan  
|                    |  • EASIA 301R The Political Economy of East Asia  
|                    |  • EASIA 303R Business Environment in East Asia  
|                    |  • EASIA 304R Korean Law and Society  
|                    |  • EASIA 305R Buddhism in East Asia Today (Cross-listed with RS 302R)  
|                    |  • EASIA 336R Korean Pop Culture  
|                    |  • EASIA 346R Global Asian Diasporas (Cross-listed with ENGL 346R)  
| Economics          |  • ECON 207 Economic Growth and Development 1  
|                    |  • ECON 231 Introduction to International Economics  
|                    |  • ECON 332 International Finance  
|                    |  • ECON 366 Gender and Economics  
|                    |  • ECON 407 Economic Growth and Development 2  
| English            |  • ENGL 108B Global English Literatures  
|                    |  • ENGL 280 Literatures of Migration  
|                    |  • ENGL 291 Global Literatures  
|                    |  • ENGL 308 Race and Resistance (Cross-listed with GSJ 307)  
|                    |  • ENGL 345 American Literature in a Global Context  
|                    |  • ENGL 346R Global Asian Diasporas (Cross-listed with EASIA 346R)  
| French             |  • FR 373 Languages in Contact: The History of French-English Bilingualism  
|                    |  • FR 473 Aspects of French Canada  
|                    |  • FR 486 Topics in French and Francophone Cultural Studies  
|                    |  • FR 487 African and Caribbean French Literature  
| Gender and Social  |  • GSJ 101 Introduction to Gender and Social Justice: the Global North  
| Justice            |  • GSJ 102 Introduction to Gender and Social Justice: the Global South  
|                    |  • GSJ 221 Language and Society (Cross-listed with ANTH 221)  
|                    |  • GSJ 260 Social Determinants of Health (Cross-listed with HLTH 260)  
|                    |  • GSJ 307 Race and Resistance (Cross-listed with ENGL 308)  
|                    |  • GSJ 401 Global Health (Cross-listed with HLTH 401)  

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<tr>
<th><strong>German</strong></th>
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<td>GER 100 Zeitgeist and Popular Culture</td>
<td>GBDA 211 Introduction to Global Business</td>
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<td>GER 200 Transcultural Studies <em>(Cross-listed with CI 200)</em></td>
<td>GBDA 301 Global Digital Project 1</td>
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<td>GER 211 Integrative Language Seminar I</td>
<td>GBDA 302 Global Digital Project 2</td>
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<td>GBDA 402 Capstone Course: Cross-Cultural Digital Business</td>
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<td>GER 301 Language, Culture, and Identity <em>(Cross-listed with APPLS 301)</em></td>
<td>HIST 220 The Vietnam War</td>
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<td>GER 303 Interactive German Language and Culture</td>
<td>HIST 221 Racism and Response in Canadian History</td>
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<td>HIST 230 Introduction to the Modern Middle East <em>(Cross-listed with PSCI 257)</em></td>
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<td>INTST 101 Introduction to International Studies</td>
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<td><strong>Jewish Studies</strong></td>
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<tr>
<td>JS 114 Jews and Jewishness <em>(Cross-listed with RS 114)</em></td>
<td>JS 364 Jewish Humour: Laughing Your Way through History <em>(Cross-listed with RS 364)</em></td>
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| **Legal Studies**          | - LS 240 Terrorism *(Cross-listed with SOC 240)*  
|                           | - LS 342 Migration and Legality *(Cross-listed with SOC 342)*  
|                           | - LS 365 Transnational Migration *(Cross-listed with PSCI 375)*  
|                           | - LS 425 Crossing Borders: Law and Global Deviance *(Cross-listed with SOC 425)*  
|                           | - LS 462 Government and Politics of Indigenous Peoples *(Cross-listed with PSCI 462)*  
| **Mennonite Studies**     | - MENN 125 Who Are the Mennonites?  
| **Peace and Conflict Studies** | - PACS 201 Roots of Conflict, Violence, and Peace  
|                            | - PACS 202 Conflict Resolution  
|                            | - PACS 311 Doing Development: Issues of Justice and Peace  
|                            | - PACS 327 Cultural Approaches to Conflict Resolution  
|                            | - PACS 390 Internship  
| **Philosophy**            | - PHIL 224 Environmental Ethics  
|                            | - PHIL 227 Culture and Ethics *(Cross-listed with INDEV 300)*  
|                            | - PHIL 237 Introduction to the Philosophy of Religion *(Cross-listed with RS 261)*  
| **Political Science**     | - PSCI 150 Introduction to Global Politics  
|                            | - PSCI 252 Global South  
|                            | - PSCI 257 Introduction to the Modern Middle East *(Cross-listed with HIST 230)*  
|                            | - PSCI 259 Government and Politics of Asia  
|                            | - PSCI 281 World Politics  
|                            | - PSCI 283 International Political Economy  
|                            | - PSCI 350 Political Economy of Development  
|                            | - PSCI 352 Culture and Political Violence  
|                            | - PSCI 355 Russia and its Neighbours  
|                            | - PSCI 358 Political Change in Greater China  
|                            | - PSCI 359 Politics of South Asia  
|                            | - PSCI 362 Cultural Politics and Indigenous Practices  
|                            | - PSCI 369 The Politics of Decolonization *(Cross-listed with HIST 369)*  
|                            | - PSCI 370 Women and Politics  
|                            | - PSCI 375 Transnational Migration *(Cross-listed with LS 365)*  
|                            | - PSCI 387 Globalization  
|                            | - PSCI 404 Globalization, International Business, and Development  
|                            | - PSCI 432 Global Environmental Governance *(Cross-listed with ERS 404)*  
|                            | - PSCI 439 Global Social Policy  
|                            | - PSCI 450 Politics of Authoritarianism  
|                            | - PSCI 454 Topics in Politics in Global South  
|                            | - PSCI 456 Ethnic Conflict and Conflict Resolution  
|                            | - PSCI 462 Government and Politics of Indigenous Peoples *(Cross-listed with LS 462)*  
|                            | - PSCI 479 International Political Economy of Asia  
|                            | - PSCI 480 China and Global Governance  
| **Psychology**            | - PSYCH 349R Cross-Cultural Psychology *(Cross-listed with SWREN 349R)*  
|                            | - PSYCH 352 Culture and Psychology  

### Religious Studies

- RS 100 Religions of Asia
- RS 110 Religions of the West
- RS 114 Jews and Jewishness *(Cross-listed with JS 114)*
- RS 123 Monsters and Magic in Japanese Popular Culture *(Cross-listed with EASIA 120R)*
- RS 202 Sikhism
- RS 203 Hinduism
- RS 204 Buddhism
- RS 206 Japanese Religions *(Cross-listed with EASIA 206R)*
- RS 216 Islam
- RS 218 Spirituality, Secularity, and Religion in Sociological Perspective *(Cross-listed with SOC 260)*
- RS 220 World Religions and Politics
- RS 227 Buddhism in North America
- RS 242R Religious Diversity and Social Development *(Cross-listed with SDS 242R)*
- RS 252 Religious Responses to Political Oppression
- RS 260 Religion Matters
- RS 261 Introduction to the Philosophy of Religion *(Cross-listed with PHIL 237)*
- RS 266 Death and Dying
- RS 275 Religion and Japanese Film *(Cross-listed with EASIA 275R)*
- RS 302R Buddhism in East Asia Today *(Cross-listed with EASIA 305R)*
- RS 312 Muslim Lives and Practices Worldwide
- RS 319 Religion in Canada
- RS 361 Anthropology of Religion *(Cross-listed with ANTH 311)*
- RS 364 Jewish Humour: Laughing Your Way Through History *(Cross-listed with JS 364)*

### Russian and European Studies

- REES 261 Understanding Conversation *(Cross-listed with GER 261)*
- REES 262 Multilingualism *(Cross-listed with GER 262)*
- REES 385 Culture behind the Iron Curtain *(Cross-listed with GER 385)*

### Sexuality, Marriage, and Family Studies

- SMF 214 Constructing Erotics
- SMF 208 Introduction to Systemic Therapies and Anti-Oppressive Practices

### Social Development Studies

- SDS 215R Education and Social Development from a Global Perspective
- SDS 242R Religious Diversity and Social Development *(Cross-listed with RS 242R)*
- SDS 323R International Perspectives in Community Org. *(Cross-listed with SOCWK 322R)*
- SDS 330R International Public Policy
- SDS 345R Self-Development and Identity Formation: A Sociocultural Perspective
- SDS 370R International Learning Experience
- SDS 388R Globalization and Social Development
- SDS 400R Comparative Social Policy
- SDS 411R Decolonization and Social Action

### Social Work

- SOCWK 301R Understanding Diversity in Canada *(Cross-listed with SWREN 301R)*
- SOCWK 322R International Perspectives in Community Org. *(Cross-listed with SDS 323R)*

### Social Work (Renison)

- SWREN 301R Understanding Diversity in Canada *(Cross-listed with SOCWK 301R)*
- SWREN 349R Cross-Cultural Psychology *(Cross-listed with PSYCH 349R)*
### Sociology
- SOC 240 Terrorism *(Cross-listed with LS 240)*
- SOC 256 Ethnic and Racial Relations
- SOC 260 Spirituality, Secularity, and Religion in Sociological Perspective *(Cross-listed with RS 218)*
- SOC 270 International Migration
- SOC 275 Mennonites as a Sociological Community
- SOC 320 Social Problems in a Global Context
- SOC 342 Migration and Legality *(Cross-listed with LS 342)*
- SOC 349 Migration and Development
- SOC 354 Comparative Health Care Systems
- SOC 425 Crossing Borders: Law and Global Deviance *(Cross-listed with LS 425)*
- SOC 431 Science as Practice and Culture *(Cross-listed with ANTH 430)*
- SOC 451 Global Development

### Spanish
- SPAN 150 The Hispanic World Through Literature and the Arts
- SPAN 217 First Nations, Native Americans, Pueblos Originarios
- SPAN 218 Parallel Revolutions in a Nascent Continent
- SPAN 387 Gender, Power, and Representations in Latin America
- SPAN 400 Memories and Representations: Constructive Truths and Competing Realities
- SPAN 410 Visual Culture in the Contemporary Hispanic World

### Speech Communication
- SPCOM 226 Introduction to Intercultural Communication
- SPCOM 402 Advanced Intercultural Communication

### Studies in Islam
- SI 131R Arab Culture
- SI 221R Islam, the West, and the Modern World
- SI 240R Migration, Diaspora, and Exile: Muslim Narratives

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### ENV

<table>
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<th>Department</th>
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<td>Environmental Studies</td>
<td>ENVS 220 Ecological Economics</td>
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<td>Environment, Resources, and Sustainability</td>
<td>ERS 225 Gendering Environmental Politics</td>
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<td>ERS 316 Urban Water and Wastewater Systems</td>
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<td>ERS 361 Food Systems and Sustainability <em>(Cross-listed with GEOG 361)</em></td>
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<td>ERS 372 First Nations and the Environment</td>
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<td>ERS 404 Global Environmental Governance <em>(Cross-listed with PSCI 432)</em></td>
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<td>Geography and Environmental Management</td>
<td>GEOG 101 Human Geographies: People, Space and Change</td>
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<td>GEOG 202 Geography of the Global Economy</td>
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<td>GEOG 203 Environment and Development in a Global Perspective</td>
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<td>GEOG 323 Tourism Impacts - International Perspectives <em>(Cross-listed with REC 383)</em></td>
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<td>GEOG 336 Spaces of Citizenship: Identities and Inequality</td>
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<td>GEOG 361 Food Systems and Sustainability <em>(Cross-listed with ERS 361)</em></td>
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<td>• INDEV 100 Introduction to International Development</td>
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<td>• SCI 250 Environmental Geology</td>
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Framework for the Assessment of Unauthorized Collaboration Involving Undergraduate Students

Established: [...]  
Revised: [...]  
Supersedes: N/A  
Responsible/Originating Department: Vice-President, Academic & Provost  
Executive Contact: Associate Vice-President, Academic  
Related Policies, Guidelines & Procedures:  
Policy 71 – Student Discipline  
Policy 73 – Intellectual Property Rights

1. General

Policy 71’s glossary defines unauthorized co-operation or collaboration, as “co-operation or collaboration with another student/other students in the completion of an academic assignment, in whole or in part, beyond what the instructor has indicated is acceptable; failure to follow the instructor’s directions regarding the level of group work that is permissible for a particular assignment.”

However, the University of Waterloo recognizes that collaboration is also a beneficial practice, both for students’ ability to learn within a course and as a practical skill for their later careers. This framework articulates guiding principles and criteria for distinguishing legitimate from unauthorized collaboration and, in the latter case, for assigning a penalty. For simplicity, we equate “co-operation” with “collaboration” in the remainder of this document.

2. Definitions and Examples

i. Legitimate collaboration is defined as collaboration that is consistent with instructor guidelines. In the absence of explicit instructions, it is reasonable for students to discuss course concepts together, even if those concepts are directly related to a current assignment. However, unless specified by an instructor, students are not generally allowed to complete an assignment together (e.g., write a paper or develop code together).

ii. Collaboration outside the parameters indicated by the instructor is referred to as unauthorized collaboration. The boundary between legitimate and unauthorized collaboration will depend on context, including the nature of the course, the assigned task, and the instructions given regarding the task (see Appendix A for examples). It is critical for instructors to be explicit – both in writing and verbally – about whether collaboration is allowed in their course, and if so, the extent to which it is allowed. It is also critical for students to understand the distinction between legitimate and unauthorized collaboration (Appendix B) and to be sure they understand what is allowed in a given course. Unless
specified explicitly, the general principle is that collaboration which results in submitted content that is the same or similar may be deemed inappropriate because it does not accurately reflect individual student understanding. Typically, the results of unauthorized collaboration will bear a similarity to plagiarism, with the essential difference being that in the former case the submissions are prepared by students working together whereas in the latter they have been obtained from an external source (or from their prior work in the case of self-plagiarism). In practice, it is not necessary for an Associate Dean (AD) to distinguish them given that the penalties here align with the framework of penalties for plagiarism.

iii. In some instances, a student may give one of their assignments from a course to a student taking the same course in a later term. The latter student’s submission of that assignment is an instance of unauthorized collaboration and both students will accordingly be subject to disciplinary action.

iv. Unauthorized collaboration may incur penalties even if it is unintentional (e.g., students believe the degree of collaboration to have been appropriate, they have made no attempt at deception, and yet have produced work with shared content which could only have resulted from collaboration). However, if there is evidence that students have an intent to deceive their instructor to obtain credit for the same work, this should lead to an enhanced penalty for collusion.

3. Principles for the Assignment of Penalties

i. Under Policy 71, the student’s AD has the authority to assess instances of unauthorized collaboration in student submissions¹ and to assign the resultant penalties, based on the Suggested Penalties for Unauthorized Collaboration (see Appendix C). An instructor may propose a grade penalty to the AD when seeking an informal resolution; the AD shall determine whether or not it is appropriate.

ii. If students have submitted original work yet there is evidence that they inappropriately collaborated, the students will be directed to campus resources that uphold the principles of proper scholarship (see Appendix B). Repeated offences may incur stiffer penalties.

iii. The presence of shared content may not be the result of collaboration. Depending on the nature of the course element, there may be features that could realistically occur in more than one submission coincidentally (e.g., from a common experience with a tutor).

iv. The severity of the penalty for unauthorized collaboration depends on the level of collaboration and the quantity of shared content submitted. Example

¹ “Submissions” refers to any work provided by a student in order to obtain credit in a course and includes (but is not limited to) essays, assignments, reports, proposals, lab reports, and presentations.
Students who collaborate during the writing of an essay, yet submit mostly original work, may receive a lighter penalty than students who submit identical essays. **Example 2:** Students who submit an identical section of a report may receive a lighter penalty than students who submit identical reports.

v. In some instances, however, students may unduly collaborate (where explicitly prohibited) in the development of a strategy for approaching a problem, in the structure of a paper, or in the sharing of a reference list. In these instances, given that the content of the assignments differs, the Associate Dean may not be able to refer to the penalties in Appendix C because they focus on the amount of shared content. The Associate Dean will thus determine a penalty based on the extent to which the assignment is considered to be a collaborative result.

vi. The impact of an academic integrity violation on a student’s mark depends on the value of the submission. As such, imposed penalties can vary from the recommendations in Appendix C in an effort to ensure that their impact is consistent with their objectives. **Example 1:** A penalty of a 100% reduction on an assignment worth 2% of a student’s final course grade is not particularly impactful, so there may be an additional 5% reduction from the final course grade. **Example 2:** A penalty of a 50% reduction in the earned grade on an assignment worth 40% of the student’s final course grade may result in a course failure, so the disciplinary decision may specify that the student’s final mark on the assignment should not produce a failure in the course. **Example 3:** Appendix C suggests that an additional 5 mark deduction may be assessed for low value elements. However, it may still be appropriate to apply it to high value elements if the quantity of shared content approaches 100%.

vii. There may be instances where unauthorized collaboration is confined to a single section within a submission that includes multiple components (such as lab reports). If the marking rubric allows, the imposed penalty may be limited to that section of the submission; in such cases, the section penalty will normally be 100%.

viii. It may be difficult to assess the origin of unauthorized collaboration within group submissions. Instructors are encouraged to ask students to identify the portions of an assignment for which they are responsible. In the absence of this identification, all students may be held equally responsible for violations of academic integrity in the group submission.

ix. Associate Deans may consider extenuating circumstances in levying penalties that are less severe than the guidelines provided in Appendix C.

x. Consistent with University policy, repeat offenders shall receive more severe penalties.
Appendix A

Examples of Acceptable and Unauthorized Collaboration

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Acceptable</th>
<th>Unauthorized Collaboration (unless authorized)²</th>
</tr>
</thead>
<tbody>
<tr>
<td>The instructor tells students that they are not permitted to collaborate on a research assignment. A student is having trouble finding references.</td>
<td>The student consults their instructor or the Librarian for help.</td>
<td>The student copies a friend’s reference list to write the research assignment.</td>
</tr>
<tr>
<td>The instructor tells students that they are not permitted to collaborate on a lab report.</td>
<td>The students do not work together at any point and submit original reports.</td>
<td>The students meet in the library and write sections of the lab report together, or collaborate through a social media site (e.g. a course Facebook group).</td>
</tr>
<tr>
<td>The instructor tells the students they are permitted to discuss course themes and concepts, but they must apply these concepts to the essay topic on their own.</td>
<td>The students meet to discuss challenging concepts, but write their essays independently using original ideas. If a student is having trouble applying concepts, they meet individually with their instructor for guidance.</td>
<td>The students meet to discuss challenging concepts, and as a group they brainstorm ways to apply these concepts to their essays.</td>
</tr>
<tr>
<td>A co-op student is preparing a cover letter, a work-term-related product (e.g., a website), or a work-term report, where it has been communicated that work is to be independent.</td>
<td>The student seeks advice from a manager or colleague, as appropriate, while completing the work on their own.</td>
<td>The student uses the material of another student or colleague in their cover letter, work product or work-term report.</td>
</tr>
<tr>
<td>A student forgets that a coding assignment is due until the evening before it is due.</td>
<td>The student cancels their plans that evening to complete the assignment, or takes a late submission penalty.</td>
<td>The student works with a friend to complete the coding assignment more quickly.</td>
</tr>
<tr>
<td>A student is having trouble with an assignment because they do not understand some of the course concepts.</td>
<td>They meet with a peer tutor for help understanding the concepts they find challenging.</td>
<td>The student asks someone who has taken the course in the past to use all or part of their assignment, or finds a previous report online.</td>
</tr>
</tbody>
</table>

² Note that these examples may not represent unauthorized collaboration; as described above, they are unauthorized only if they have been stipulated as such.
Appendix B

Achieving Academic Success

Students are strongly encouraged to consider the root cause(s) of unauthorized collaboration and to use one or more of the following resources, workshops and/or courses to learn how to avoid academic misconduct under Policy 71 – Student Discipline.

Note: The distinction between unauthorized collaboration and plagiarism is not always clear, so resources targeted at avoiding plagiarism have been included in this list.

<table>
<thead>
<tr>
<th>HELP NEEDED:</th>
<th>HELP PROVIDED:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course-specific expectations</strong></td>
<td>● Consult your course outline to understand what is allowable in a specific course</td>
</tr>
<tr>
<td>Each instructor may have different</td>
<td>● Ask your course instructor to clarify what is allowable.</td>
</tr>
<tr>
<td>expectations to define acceptable</td>
<td>● Your course instructor or librarian may also be able to suggest alternative</td>
</tr>
<tr>
<td>and unacceptable behaviours for</td>
<td>resources.</td>
</tr>
<tr>
<td>collaborating on course work</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Course-specific help</strong></td>
</tr>
<tr>
<td>Struggling with course concepts or content</td>
<td>● Talk or collaborate with a classmate, though be sure that you are working</td>
</tr>
<tr>
<td></td>
<td>within the constraints set by your course instructor.</td>
</tr>
<tr>
<td></td>
<td>● Connect with your TA or find a tutor who can help you better understand</td>
</tr>
<tr>
<td></td>
<td>the course content on your own.</td>
</tr>
<tr>
<td></td>
<td>● See the list of campus-wide Course Specific Help or Tutor Connect.</td>
</tr>
<tr>
<td></td>
<td>● Your course instructor may also be able to suggest alternative resources to</td>
</tr>
<tr>
<td></td>
<td>help build course-specific skills.</td>
</tr>
<tr>
<td><strong>Writing skills</strong></td>
<td>● Attend a Writing and Communication Centre (WCC) workshop – e.g., “Turbo</td>
</tr>
<tr>
<td>Unsure how to write in own words or</td>
<td>Charge Your Term Paper”</td>
</tr>
<tr>
<td>organize ideas</td>
<td>● Review WCC writing resources.</td>
</tr>
<tr>
<td></td>
<td>● Use WriteOnline resources for writing case studies, reflective essays,</td>
</tr>
<tr>
<td></td>
<td>literature reviews, and lab reports.</td>
</tr>
<tr>
<td></td>
<td>● Meet with a WCC writing specialist by booking an appointment or attending a</td>
</tr>
<tr>
<td></td>
<td>drop-in session at the Library.</td>
</tr>
<tr>
<td><strong>Stress and time management skills</strong></td>
<td>● Attend Student Success Office workshops – e.g., “Get this term started” and</td>
</tr>
<tr>
<td>Struggling with workload stress,</td>
<td>“Organizing Your Time”</td>
</tr>
<tr>
<td>sufficient time for course work and/or</td>
<td>● Review Student Success Office time management resources – e.g., “Backwards</td>
</tr>
<tr>
<td>how to approach large assignments</td>
<td>Planning”</td>
</tr>
<tr>
<td></td>
<td>● Book Peer Success Coach appointment</td>
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<tr>
<td></td>
<td>● Contact Counselling Services for individual appointments, workshops, or</td>
</tr>
<tr>
<td></td>
<td>UW MATES peer support</td>
</tr>
</tbody>
</table>
| Referencing and research skills                                                                 | • Use Library [Find and Use Resources, subject guides, and Quick Start Guide](#)  
|                                                                                                 | • Review [Citing Sources](#) and use [citation management software](#), like [RefWorks](#), to track and format citations  
|                                                                                                 | • Attend [Library workshops](#) – e.g., “Citing Properly with RefWorks”  
|                                                                                                 | • Review [Avoiding Plagiarism or How to Successfully Use the Works of Others](#)  
|                                                                                                 | • Contact a subject librarian or try [Ask us](#) for help  
| Motivation and interest                                                                        | • Meet with an academic advisor  
|                                                                                                 | • Attend a [Centre for Career Action](#) appointment drop-in time or workshop to understand relevance of course work  
|                                                                                                 | • Consider connecting with upper year peers or your program’s student society to discuss your program and related future opportunities, courses, etc.  
| Understanding unauthorized collaboration consequences                                          | • Review [Office of Academic Integrity](#) resources:  
|                                                                                                 |   • [Introduction to Policy 71](#)  
|                                                                                                 |   • Academic integrity tutorial  
|                                                                                                 |   • 10 tips to avoid academic misconduct  
|                                                                                                 |   • Academic integrity fact sheet for students  
| Writing courses                                                                                | • Take a writing-intensive course:  
|                                                                                                 |   • [ENGL 101B](#): Introduction to Rhetorical Studies  
|                                                                                                 |   • [ENGL 109](#): Introduction to Academic Writing  
|                                                                                                 |   • EMLS 129/ENGL 129R: Written Academic English  
|                                                                                                 |   • [ENGL 140R](#): The use of English 1  
|                                                                                                 | • Consider taking a course on effective collaboration  
|                                                                                                 |   • [INTEG 210](#): Making Collaboration Work  

Appendix C

Suggested Penalties for Unauthorized Collaboration

<table>
<thead>
<tr>
<th>Level 1 Penalties$^3$</th>
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<tbody>
<tr>
<td>Unauthorized collaboration resulting in shared or similar content.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1a.</th>
<th>1b.</th>
<th>1c.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2 lines or sentences of shared content</td>
<td>Up to 25% of course element</td>
<td>More than 25% of course element</td>
</tr>
<tr>
<td>• 25% of earned grade deduction</td>
<td>• 50% of earned grade deduction</td>
<td>• 100% of earned grade deduction</td>
</tr>
<tr>
<td>• Probation</td>
<td>• Probation</td>
<td>• Probation</td>
</tr>
</tbody>
</table>

An additional penalty up to 5% of the final grade may be implemented, in particular for offences occurring on low-valued course elements (i.e., elements worth less than 10% of a student’s grade)

$^3$ Although there is only one level in these guidelines, this framework has been designed to parallel the one for plagiarism where there are additional levels.