Calendar Home

One Hundred and Twenty Eighth Session

The Calendar on the Engineering and Applied Science website is an official publication of the Faculty Board. This Calendar is the prevailing and official record of the academic regulations, academic plans of study, descriptions of courses of instruction, and requirements for graduation in all undergraduate plans in the Faculty. It can only be amended by Faculty Board. Amendments will be recorded in the Minutes of the Board and are included in the on-line Calendar.

Students looking for the 2015-2016 - 2020-2021 Calendars, please use the dropdown menu above to the right of your screen. For calendars prior to the 2015-2016 Academic Calendar, please click here

About this Calendar

This online calendar (acalog™) contains a number of features that can assist you with your academic planning. Some of these features include:

1. Advanced, easy-to-use search options
2. Intuitive navigation
3. Printable Degree Planners
4. Personal Portfolio to store favourite programs, courses and pages
5. Print-friendly pages

For information on how to use these features, please see our FEAS Calendar User Guide .

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Glossary

Academic Plan

A specified combination of courses leading to a degree in a particular subject.

Academic Program

Refers to the degree program of study that a student is pursuing, i.e., Bachelor of Applied Science or special programs such as UASC, UBUS, UEDU.

Associate Dean (Academic)

In charge of undergraduate studies for the Faculty.

AU

Academic Units, numerically equal to CEAB Accreditation Units.

Board of Trustees

The senior administrative body of the University.

BTech

Bachelor of Mining Engineering Technology

Bursary

Financial award for a student in need.

Calendar

An official publication of academic regulations, plans of study, descriptions of courses of instruction, and requirements for graduation.

CEAB

Canadian Engineering Accreditation Board.

CS: Complementary Studies

Topics in Engineering Economics, Communications, Management, Humanities and Social Sciences, Linkage and Professional Issues, and Performance Arts and Languages.

Confidential Examination

An examination paper recovered after the examination and withheld from circulation or publication.

Core

Those courses which are a mandatory part of an academic plan.

Corequisites

Courses which must be taken at the same time as the course in question, or have previously been taken and passed.

Credit

To attribute to an academic record, the accreditation units for a similar course of instruction.

Dean

The Chief Executive Officer of the Faculty.

Department

A subdivision of the Faculty responsible for a particular subject or group of related subjects, or an academic plan.

ECGPA

Engineering Cumulative Grade Point Average - see Regulation 16c for definition.

EGGPA

Engineering Graduation Grade Point Average - see Regulation 3 for definition.

Electives

A group of courses from which a specified number must be chosen to satisfy part of the requirements for the degree.

Engineering Design

Development of elements, systems and processes using mathematics, science and engineering science to meet specific needs and constraints.

Engineering Science

Application of mathematics and basic sciences to the identification and solution of engineering problems.

Engineering Session

Defined as the Fall and Winter terms of the academic year, provided the student is registered in the FEAS for both of these sessions.

Engineering Student

A student registered in the FEAS.

ETGPA

Engineering Term Grade Point Average - see Regulation 3 for definition.

Exemption

A required course replaced in an academic plan by relevant Work Experience plus an equivalent number of Accreditation Units extra to the academic plan approved by the Operations Committee.

Extended Program

An extension of Year One into the spring term allowing more time for the study of mathematics, chemistry and physics to assist first year students having difficulties in those subjects.

Faculty Board

The Committee charged with overseeing all academic matters in the Faculty.

FEAS

Faculty of Engineering and Applied Science.

GPA

Grade Point Average - see Regulation 16a for definition.

H & SS

Humanities and Social Sciences.

IAESTE

International Association for the Exchange of Students for Technical Experience.

Internship

A twelve or sixteen month period in industry, arranged by the University, for academic credit.

Letter of Permission

A formal document allowing a student to take a course at another institution in lieu of one in the student's regular academic plan.

Natural Sciences

Physics, Chemistry, Earth and Life Sciences.

Operations Committee

A standing committee of Faculty Board which deals with Admissions, Scholarships, Academic Progress, and Curriculum matters.

P.Eng.

Professional Engineer, registered by a Provincial licensing authority.

PEO

Professional Engineers Ontario: The licensing authority in Ontario.

Prerequisites

Courses which must be passed before the course in question can be taken.

Principal

The Chief Executive Officer of the University.

Prior Learning Assessment (PLA)

Challenge Examinations in First Year Subjects.

QUIP

Queen's Undergraduate Internship Program.

Reading Week

A period in which classes are suspended in favour of independent study.

Regular Session

A Regular Session normally consists of the Fall, Winter and Summer terms of instruction. In the case of first year students registered in the Extended Program, the Regular Session includes the Spring term.

Regulations

The rules established by the Faculty Board and by the Senate by which a student's academic progress and deportment are governed.

Reread

The reassessment of a student's final paper in a course, on appeal.

SAL

Student Assistance Levy.

Scholarship

A financial award based on academic merit.

Senate

The University's senior academic board.

SOLUS

Student On-Line University System

Sub-plan

One of two or more streams within an academic plan: eg., the Chemical Process Sub-plan in Chemical Engineering.

Substitution

Replacement of a required course, stipulated in the calendar, by another course, with the approval of the Operations Committee.

SURP

School of Urban and Regional Planning.

Term

A period of instruction, usually of 12 weeks duration.

Transcript

A document provided by the Registrar's Office that lists the entire academic record-to-date of a student in the University. An Official Transcript is certified by the Registrar.

Transfer Credit

Credit allowed for a course taken in another Faculty or at another institution.

Withdrawal

A formal process for discontinuing studies in a course or in an academic plan.

Important Dates

Dates apply to the Fall-Winter academic year beginning in September 2019. See Sessional Dates for a complete list. https://www.queensu.ca/registrar/key-dates

September 2021

4 Residence move-in day

4 Welcoming Ceremony for new students

6 Labour Day (University closed. Classes will not be held)

7 Fall term classes begin

22 Last day to register without extra fee. After this date, students must appeal in writing to the Operations Committee for permission to register late.

29 Last day to apply to graduate for Fall 2021 Degree List

October 2021

11 Thanksgiving Day (University closed. Classes will not be held)

November 2021

NOTE: Fall 2021 Convocation Dates will be published by the Office of the University Registrar in May 2021. Refer to http://www.queensu.ca/registrar/convocation to view these dates.

7 Last date to apply for accommodation for an official examination conflict for the December examination period.

15 Last date to apply for admission to the Upper-Year program at the Bader International Study Centre for Winter term.

December 2021

1 Last day to apply for admission to Dual Degree in Arts and Science for the next Winter Term

1 First day to apply to graduate for Spring 2022 Degree List

1 Last day to apply for an Academic Plan Change (discipline change)

7 Review Sessions for Fall 2021 – Engineering classes only (Make-up day for Thanksgiving Day Monday (Engineering classes only)

15 Last day for late application for Academic Plan Change (discipline change) for the Winter term.

January 2022

14 Last day to apply for the exchange program for 2021-2022 (tentative)

17 Last day to apply to rewrite a First Year Fall course examination (APSC 111, APSC 131, APSC 151 and APSC 171) which take place in February Reading Week

19 Academic Plan (Discipline) Orientation for First Year Students begins

21 Last day to withdraw from degree program without failure of year.

21 Last day to cancel an application to rewrite a First Year Fall course examination without academic penalty.

February 2022

1 Academic Plan Selection for First Year Students begins on SOLUS (tentative)

7 Registration for Summer Term classes begins.

25 Academic Plan Selection for First Year Students ends on SOLUS (TENTATIVE)

28 Last day to apply to graduate for Spring 2022 Degree List (TENTATIVE)

March 2022

7 Last date to apply for accommodation for an official examination conflict for the April examination period

31 Last day to apply for admission to upper year courses at the International Study Centre for Spring-Summer session

April 2022

1 Last day to apply for admission to Dual Degree in Arts and Science for the Summer Term

15 Good Friday (Classes not held)

May 2022

1 Extended Program Fees due

1 Summer tuition fees are due in full for summer term classes

13 Last day for eligible students in the regular First Year program to register to rewrite exams for Winter First Year courses (APSC 112, APSC 132, APSC 172, and APSC 174)

23 Victoria Day (University closed. Classes will not be held)

27 Last day to withdraw from rewrite exams for Winter First Year courses

June 2022

NOTE: Spring 2022 Convocation dates will be published by the Office of the University Registrar in November 2021. Refer to http://www.queensu.ca/registrar/convocation to view these dates

1 Last day to apply to transfer into the Faculty of Engineering and Applied Science for the Fall term

1 Last day to apply for Dual Degree Program for the next Fall-Winter session

10Last day to apply for supplemental examination privileges

July 2022

1	Canada Day (No classes held)
11-29	Summer class selection period for Fall and Winter Term classes (TENTATIVE)
15	First date to apply in SOLUS to graduate in Fall 2022 (TENTATIVE)
31	Last date to apply for admission to the Upper-Year program at the Bader International Study Centre for Fall term
31	Last date to apply for an Academic Plan Change (discipline change) for the Fall term

August 2022

1	Civic Holiday (University closed. Classes will not be held)
15	Last day for late application for Academic Plan Change (discipline change) for the Fall term.
15	Time period to add and drop classes (open enrolment period) begins (Tentative)

2022 - SUPPLEMENTAL EXAM PERIOD

Aug. 31, 2022 September 1 & 2, 2022 - Three day Supplemental exams take place on campus prior to Fall term start.

Sessional Dates

FEE DEADLINES: Fee deadlines are not listed in the Sessional Dates, and do not necessarily correspond with academic deadlines. Information on deadlines for dropping courses without financial penalty is contained in the Guide to Registration and Fees available from the Office of the University Registrar on the web at http://www.queensu.ca/registrar/currentstudents/fees.html

EXAMINATION REREADING DEADLINES: The attention of students is drawn to Regulation 13 concerning deadlines for making application to reread examination papers.

April 2019

29 Extended Program Spring Term begins

May 2019

1 Summer Term begins

1 Tuition fees due in full for Summer Term classes (May-June/6W1 and May-July/12W Sessions).

1 Extended Program Fees are due

1 Last day for student consultations regarding Dual Degree in Economics application

6 Summer Term classes begin (May-June/6W1 and May-July/12W Sessions).

10 Last date to add Summer Term classes (May-June/6W1 and May-July/12W Sessions).

10 Last date to drop Summer Term classes (May-June/6W1 Session) without financial penalty.

10 Last date to apply for admission to the Upper-Year Program at Bader International Study Centre for Summer Term (August Session).

17 Last date to drop Summer Term classes (May-July/12W Session) without financial penalty.

17 Last day for eligible students in the regular First Year program to register to rewrite the exam for Winter First Year courses (APSC 112, APSC 132, APSC 172, and APSC 174)

20 Victoria Day (classes will not be held)

24 Last day to pay administrative fee for rewrite exams in Winter Term courses of the First Year program that are written in a location other than Kingston

31 Last date to drop Summer Term classes (May-June/6W1 Session) without academic penalty.

31 Last day to withdraw from rewrite exams for Winter Term First Year courses

June 2019

NOTE: Spring 2020 Convocation dates will be published by the Office of the University Registrar in November 2019. Refer to http://www.queensu.ca/registrar/convocation/ceremonies to view these dates.

1 Last day to apply for Dual Degree Program for the next Fall-Winter session

7 Last date to apply for accommodation for an official examination conflict for the June, July and August examination sessions.

14 Extended Program classes end

14 Last day to apply for supplemental examination privileges

17 Summer Term classes end (May-June/6W1 Session).

17-21 Extended Program Winter course examinations

17-21 Summer Term examinations in May-June/6W1 Session classes (TENTATIVE).

28 Last date to drop Summer Term classes (May-July/12W Session) without academic penalty.

July 2019

1 Tuition fees due in full for Summer Term classes (July-August/6W2 Session).

1 Canada Day observed (University closed. Classes will not be held).

2 Summer Term classes begin (July-August/6W2 Session).

8 Last date to add Summer Term classes (July-August/6W2 Session).

8 Last date to drop Summer Term classes (July-August/6W2 Session) without financial penalty.

15-24 Summer class selection period for Fall and Winter Term classes begins (TENTATIVE).

15 First day to apply to graduate for Fall 2019 Degree List (tentative).

26 Summer Term classes end (May-July/12W Session).

29 Last date to drop Summer Term classes (July-August/6W2 Session) without academic penalty.

30 Summer Term examinations in May-July/12W Session classes begin (TENTATIVE).

31 Last day to apply for admission to the upper-year courses at the Bader International Study Centre for Fall term.

31 Last day to apply for an Academic Plan Change (discipline change) for the Fall term

August 2019

2 Summer class selection period for Fall and Winter Term classes ends (TENTATIVE)

2 Summer Term examinations in May-July/12W Session classes end (TENTATIVE)

5 Civic Holiday (University closed. Classes will not be held)

12 Summer Term classes end (July-August/6W2 session)

14-15 Summer Term examinations in July-August/6W2 Session classes (TENTATIVE)

15 Last day for late application for Academic Plan Change (discipline change) for the Fall term

16 Last day to cancel application for supplemental examinations without academic or financial penalty

27 Time period to add and drop classes (open enrolment period) begins (TENTATIVE)

31 Summer Term ends

31 Residence Move-in Day

31 Welcoming Ceremony for new students

31 Orientation Week begins (Arrival day)

September 2019

1 Fall Term begins.

1 Tuition fees due in full for Fall Term classes - Exception: OSAP students

2 Labour Day (University closed. Classes will not be held)

3-4 Supplemental Examinations

5 Fall Term classes begin

7 Supplemental Examinations

13 Last date to apply for an academic plan change from one plan in Engineering to another plan in Engineering for the Fall term

18 Last date to:

- Drop Fall Term and Fall-Winter session course without financial penalty
- Register without extra fee. Afer this date, students must appeal in writing to the Operations Committee for permisson to register late
- Add a Fall term course of a Fall-Winter sessional course
- Add a Fall term course or a Fall-Winter sessional course

30 Deadline for payment of residence, UHIP and student activity fees

30 Last day to apply to graduate for Fall 2019 Convocation (TENTATIVE)

October 2019

14 Thanksgiving Day (University closed. Classes will not be held)

16 University Day

24-25 Fall Term Break

November 2019

NOTE: Fall 2019 Convocation: Dates will be determined in May 2019. Refer to http://www.queensu.ca/registrar/convocation/ceremonies to view these dates.

1 Last day to drop a Fall Term course without academic penalty

7 Last date to apply for accommodation for an official examination conflict for the December examination period.

11 Remembrance Day Service (Classes cancelled 10:30-11:30 a.m.)

15 Last date to apply for admission to the Upper-Year program at the Bader International Study Centre for Winter term.

29 Fall Term classes end.

30 Fall Term pre-examination study period begins

December 2019

1 Last day to apply for admission to Dual Degree in Arts and Science for the next Winter Term

1 First day to apply to Graduate for Spring 2020 Degree List (tentative)

1 Last day to apply for an Academic Plan Change (discipline change) for the Winter term

2 Make-up day for Thanksgiving Monday (Engineering classes only)

3 Fall Term pre-examination study period ends

4-19 Fall Term examination period

6 Commemoration Day (All academic activity with the exception of clinical and field work will be cancelled)

15 Last day for late application for Academic Plan Change (discipline change) for the Winter term

31 Fall Term ends

January 2020

1 Winter Term begins

1 New Year's Day (University closed. Classes will not be held)

6 Winter Term classes begin

10 Tuition Fees due in full for Winter term - Exception: OSAP students

10 Last date to apply for an academic plan change from one plan in Engineering to another plan in Engineering for the Winter term

10 Last day to apply for the exchange program for 2019-2020 (tentative)

13 Extended Program classes begin for APSC 111, APSC 131, and APSC 171

13 Last day to apply to rewrite a First Year Fall course examination (APSC 111, APSC 131, and APSC 171) which take place in February Reading Week

17 Last Date to:

- Drop a Winter Term course without financial penalty
- Add a Winer Term course
- Withdraw from degree program without failure of year

17 Last day to cancel an application to rewrite a First Year Fall course examination without academic penalty

17 Last day to add a Fall Extended Program course

21 Academic Plan (Discipline) Orientation for First Year Students begins

24 Last day to drop a Fall Extended Program course

February 2020

TBA Last day to apply to graduate for Spring 2020 Degree List

3 Registration for Summer Term classes begins

3 Academic Plan Selection for First Year Students begins on SOLUS (tentative)

17 Family Day (University closed. Classes will not be held)

18-21 Extended Program Fall course examinations

18-21 Mid-Term Reading Week (Classes will not be held)

24 Extended Program Classes begin for APSC 112, APSC 132, APSC 172, and APSC 174

15 Last day of classes for Extended Program APSC 111, APSC 131, and APSC 171

28 Last day to drop a Winter Term course without academic penalty

TBA Academic Plan Selection for First Year Students ends on SOLUS

March 2020

2 Last day to add/drop APSC 151 and/or APSC 161 rewrite examination in April

7 Last date to apply for accommodation for an official examination conflict for the April examination period.

30 Last day to apply for admission to upper year courses at the International Study Centre for Spring-Summer session

April 2020

1 Last day to apply for admission to Dual Degree in Arts and Science for the Summer Term

3 Winter term classes end

3 Last date to add a Winter Extended program course (with permission of the Associate Dean-Academic)

6 Last date to drop a Winter Extended program course

4-8 Winter Term pre-examination study period

9-25 Winter Term examination period

10 Good Friday (University closed. Classes will not be held)

30 Winter Term ends

May 2020

1 Summer Term begins

1 Tuition fees due in full for Summer Term classes - Exception: OSAP students

1 Extended Program Fees are due

4 Extended Program Spring Term begins

4 Summer Term classes begin (May-June/6W1 and May-July/12W Sessions).

8 Last date to add Summer Term classes (May-June/6W1 and May-July/12W Sessions).

8 Last date to drop Summer Term classes (May-June/6W1 Session) without financial penalty.

15 Last date to drop Summer Term classes (May-July/12W Session) without financial penalty.

15 Last day for eligible students in the regular First Year program to register to rewrite exams for Winter First Year courses (APSC 112, APSC 132, APSC 172, and APSC 174)

18 Victoria Day (University closed. Classes will not be held)

22 Last day to pay administrative fee for rewrite exams in Winter Term courses of the First Year program that are written in a location other than Kingston

29 Last date to drop Summer Term classes (May-June/6W1 Session) without academic penalty.

29 Last day to withdraw from rewrite exams for Winter First Year courses

June 2020

NOTE: Spring 2019 Convocation dates will be published by the Office of the University Registrar in November 2018. Refer to http://www.queensu.ca/registrar/convocation/ceremonies to view these dates.

1 Last day to apply for Dual Degree Program for the next Fall-Winter session

12 Last day to apply for supplemental examination privileges

12 Extended Program classes end

15-19 Extended Program Winter course examinations

15 Summer Term classes end (May-June/6W1 Session).

18-19 Summer Term examinations in May-June/6W1 Session classes (TENTATIVE).

26 Last date to drop Summer Term classes (May-July/12W Session) without academic penalty.

July 2020

1 Canada Day (University closed. Classes will not be held)

1 Tuition fees due in full for Summer Term classes (July-August/6W2 Session) - Exception: OSAP students

2 Summer Term classes begin (July-August/6W2 Session).

8 Last date to add Summer Term classes (July-August/6W2 Session).

8 Last date to drop Summer Term classes (July-August/6W2 Session) without financial penalty.

13-31 Summer class selection period for Fall and Winter Term classes (TENTATIVE)

15 First date to apply in SOLUS to graduate in Fall 2020 (TENTATIVE)

24 Summer Term classes (May-July session) end

29 Last date to drop Summer Term classes (July-August/6W2 Session) without academic penalty.

28-31 Summer Term examinations for May-July/12W Session classes begin (TENTATIVE).

31 Last date to apply for admission to the Upper-Year program at the Bader International Study Centre for Fall term.

August 2020

3 Civic Holiday (University closed. Classes will not be held)

10 Summer Term classes end (July-August/6W2 Session).

12-13 Summer Term examinations in July-August/6W2 Session classes (TENTATIVE).

25 Time period to add and drop classes (open enrolment period) begins (Tentative)

31 Summer Term ends

September 2020

1 Fall Term begins

1 Tuition fees due in full for Fall Term classes - Exception: OSAP students

5 Orientation Week begins (arrival day)

5 Welcoming Ceremony for new students

7 Labour Day (University closed. Classes will not be held)

10 Fall Term classes begin

***Please note**: Faith Dates are not included in the Academic Calendar. Please be aware of Faith Dates when coordinating any events in your department. For Faith Dates, please see the Human Rights web site at: http://multifaithcalendar.org/cal/index.php

Undergraduate Academic Plan

Structure and Definitions

The Faculty of Engineering and Applied Science offers degree programs in ten academic plans. Plans nominally of four years' duration lead to the degree of Bachelor of Applied Science in Engineering. Five-year plans, which include an Internship, lead to the degree of Bachelor of Applied Science in Engineering with Professional Internship. The codes for these plans and the prefix used throughout this Calendar for the courses in those disciplines are given below. **The First Year is common to all academic plans.**

Program	*Program Code*	*Course Prefix*
Chemical Engineering	CHEE	CHEE
Civil Engineering	CIVL	CIVL
Computer Engineering	CMPE	SOFT, CMPE or ELEC
Electrical Engineering	ELEC	ELEC
Engineering Chemistry	ENCH	ENCH
Engineering Physics	ENPH	ENPH
Geological Engineering	GEOE	GEOE
Mathematics and Engineering	MTHE	MTHE
Mechanical Engineering	MECH	MECH
Mining Engineering	MINE	MINE
Faculty Courses		APSC
Multi-department Courses		MDEP

There are five major components to each of these academic plans:

MATHEMATICS: Elements of algebra, calculus, differential equations, probability, statistics and numerical analysis;
NATURAL SCIENCE: Elements of Physics and Chemistry, and in some plans, elements of Earth and Life Sciences;
COMPLEMENTARY STUDIES: Topics in Engineering Economics, Communications, Management, Humanities and Social Sciences, Linkage and Professional Issues, and Performance Arts and Languages. Engineering Sciences and Engineering Design constitute about half of the plan in each case, with the other components approximately equal to each other in weight.

ENGINEERING SCIENCE: Extension of Mathematics and Basic Sciences toward creative applications;
ENGINEERING DESIGN: The application of Mathematics, Science, and Engineering Science to meet specific needs; and

Program Accreditation and Licensing The licensing of engineers in Canada is a provincial and territorial matter. Bodies such as Professional Engineers Ontario (PEO) are established by statute to govern the profession. The Canadian Council of Professional Engineers (CCPE) is the national federation of these governing bodies. A standing committee of CCPE, the Canadian Engineering Accreditation Board (CEAB), is responsible for identifying those educational programs that meet the academic standards required for membership in the profession. From time to time the Faculty of Engineering and Applied Science submits its academic plans to the CEAB for review. All of the academic plans in the Faculty of Engineering and Applied Science are accredited by the CEAB.

Note: *Effective May 1, 2011, the Faculty of Engineering and Applied Science moved each course weight from accreditation units (AU) to credit units. This means, for example, that instead of a weighting of 36 AU, a course will now count as 3 credits. In order to determine the new credit weighting for each course, the AU was divided by 12 and, if needed, rounded to the nearest quarter (0.25, 0.50 or 0.75).*

Academic Plan and Course Symbols and Codes: Plans are identified by a four-letter code (see table above). Courses are identified by:- a four letter code and a three digit number (the first of which identifies the year of the plan in which the course would normally be taken - i.e. 174 is a year one course); - a title; - a letter or letters indicating the term (F=Fall, W=Winter, FW=Fall **AND** Winter, F/W=Fall **OR** Winter, S=Summer, N/O=Not Offered);- a series of numbers indicating the units assigned to lectures (1 credit = one 50 minute lecture) and to laboratory assignments, tutorial, and significant project work (0.5 credits = one hour).

For example, the codes for a typical entry are:

- APSC 174 Introduction to Linear Algebra W, S | 3.3

This is a Faculty course normally taken in the first year. It is offered in the Winter term, will have 36 fifty-minute lectures (3 lectures per week); no lab; twelve hours in tutorials (one hour per week). The final number is the sum of the accreditation units, and represents the weight of the course. A section on Course Descriptions appears elsewhere in this Calendar.

Requirements for Graduation The minimum number of Accreditation Units required for graduation is stipulated for each of the academic plans in the Faculty. These minimum form part of the curriculum of each plan as described later in the Degree Program section of this Calendar. The minimum number varies from plan to plan, but in the current year all are greater than 1850 AU.

Minimum Requirements for CEAB Accreditation

The Canadian Engineering Accreditation Board (CEAB) requires all that all graduates from accredited engineering programs have Academic Units (AUs) at the time of graduation which meet ALL the following conditions 1-3:

1. Minimum AUs in the following five categories:

M	195AU	Mathematics
NS	195AU	Natural Science
CS	225AU	Complementary Studies
ES	225AU	Engineering Science
ED	225AU	Engineering Design

2. The sum of the AUs in these five categories shown above must be at least **1850 AUs.**
3. Two sums of categories must also meet minimum requirements as shown below e.g. the sum of AUs in Mathematics and Natural Sciences must be at least 420 AU, and the sum of AUs in Engineering Science and Engineering Design must be at least 900 AU:

M+NS	420AU	Mathematics(195 AUs or more) + Natural Science (195 AUs or more)
ES+ED	900AU	Engineering Science (225 AUs or more) + Engineering Design (225 AUs or more)

4. Within the broad five categories, it is expected that time will be spent on such topics as safety procedures, public and worker safety, ethics, equity, and concepts of sustainable development and of environmental stewardship.

   The number of AUs in each of the five categories is listed at the end of each course description in the calendar (provide a link to the calendar). The AUs are listed in the format of (M/NS/CS/ES/ED). For example:

   - MECH 230 Applied Thermodynamics I F | 3.5

   An introductory course in thermodynamics. Topics include: properties and behaviour or pure substances, concepts of heat, work and energy, the First and Second Laws of Thermodynamics, and the analysis of a variety of power and refrigeration cycles. (0/33/0/9/0)

   The numbers in parentheses at the end of the course description are the AUs. This course has 0 Math AUs, 33 Natural Science AUs, 0 Complementary Studies AUs, 9 Engineering Science AUs, and 0 Engineering Design AUs.

   This course involves three lectures hours and one tutorial hour per week for the twelve *weeks of the Fall term and therefore is assigned a weight of 3.5 credits which equates to 42 (AU) accreditation units. Of these, 33 units deal with topics in the Basic Sciences, and 9 are in Engineering Science. The course contains no Mathematics per se, no Complementary Studies, and no Engineering Design.*

APSC 199 English support for Engineers

Students in all academic plans are required to demonstrate the ability to communicate effectively in written English. Within their first year, students registering in APSC 199 must attempt a written English proficiency test. Students who do not pass on the initial attempt will have further opportunities, and need to pass the test to meet the prerequisite for APSC 200, the second year design course. A student must pass APSC 199 to be eligible for graduation.

Dual Degrees

Dual degrees are offered by the Faculty of Arts and Science can be taken concurrently with a degree in Engineering and Applied Science. Students must apply for admission through the Admission Services Office after one year at Queen's. To be accepted into a Dual Degree program in Engineering and Applied Science, you must have a minimum cumulative GPA of 2.60 or higher. The application deadline for summer term entry is **1 April**, fall term entry is **1 June** and for winter term entry is **1 December**. Candidates must have completed at least one year of study in their current academic plan and must be in good academic standing. Dual Degree programs will normally take at least one extra years of study, although some combinations of programs will be longer. Usually the path to be followed is intricate and requires the advisement of the Dual Degree Coordinator in the Engineering and Applied Science program. Dual Degree students share 60.0 units from their Engineering degree with their Arts and Science degree. Students must register in additional courses required for their 2nd degree and these additional courses must all be completed at Queen's. Fees for courses registered under the Arts and Science degree will be assessed according to the Faculty of Arts and Science. Further information can be found at https://my.engineering.queensu.ca/Current-Students/dual-degrees

Queen's University Internship Program (QUIP)

The Professional Internship Program allows qualified students the opportunity to pursue career related positions for 12 or 16 months after completion of their second or third year of study at Queen's. (This program is available to students in all programs in the Faculty.)

Job openings under this program are posted online by Career Services. A student will have access once they register in the Internship Program.

In addition to the industrial experience for which the intern earns a salary, the Program includes prior workshops on resume preparation, interviewing, work performance, and employer expectations. Successful completion of the program requires submission of a formal report or presentation, and a satisfactory assessment of the intern's performance by the Employer. Up to twelve months of the work may meet the criteria for professional work experience required for licensure as a Professional Engineer in Canada.

The 12-month program requires registration in three courses, and the 16-month program requires registration in four courses - each course is 1-term in duration. These are: APSC 301 , APSC 302 , APSC 303 , and APSC 304 . There is a special academic fee for these courses. (See the section on Fees in this Calendar.)

Details on the Internship Program can be obtained from the Career Services Office in Gordon Hall, and from their website at http://careers.queensu.ca/. The Engineering and Applied Science Internship Coordinator is George Sweetman, sweetmng@queensu.ca.

University Exchange Programs

The Faculty of Engineering and Applied Science offers student exchanges with other universities around the world. An exchange student can spend up to one year (one or two terms) at the host university in a program approved by the Department and the Operations Committee. In most instances the student can satisfy the requirements for graduation from Queen's in the usual four-year time frame. Details on these programs and a list of the host institutions can be found at http://my.engineering.queensu.ca/Current-Students/Exchange-Programs/index.html. Details on the IAESTE program can be obtained from the Queen's University International Centre, John Deutsch University Centre.

Non-academic Student Services and Resources

Information on the services and resources available to students at Queen's, such as housing, medical services, and student activities, can be found on the Division of Student Affairs web page at https://www.queensu.ca/studentaffairs/, or the Faculty general web address at http://engineering.queensu.ca/. The services of the Engineering Society are listed at http://engsoc.queensu.ca.

First Year Studies

First Year Studies, B.A.Sc.

The first year of study in Engineering and Applied Science is based on a common curriculum and serves as an introduction to all of the academic plans offered by the Faculty. The choice of academic plan the student intends to follow in the second and subsequent years is made in February in the Winter Term of the first year.

Electrical and Computer Engineering Innovation (ECEi) Stream

This program is intended for students with an interest in innovation and entrepreneurship who want to enter electrical or computer engineering in first year. The ECEi focuses on developing entrepreneurial skills alongside the technical and professional elements that are the hallmark of Queen's Engineering.

In the first year of the program students will take broad fundamental courses in math, science, and professional skills supplemented by an entrepreneurial design project specifically designed with for ECEi students. At the end of first year students choose between electrical or computer engineering, and develop strong technical fundamentals and skills necessary for innovation including economics and business practices, design and creativity, and teamwork.

Details about these streams are listed in the calendar at: https://calendar.engineering.queensu.ca/preview_program.php?catoid=8&poid=499&returnto=213

First Year Curriculum

- APSC 100 Engineering Practice l FW | K9
- APSC 199 English Proficiency for Engineers FW, S | K0.2

- APSC 111 Physics I F | 3.3
- APSC 131 Chemistry and Materials F | 3.3
- APSC 143 Introduction to Computer Programming for Engineers F | 3.3
- APSC 151 Earth Systems Engineering F | 3.3
- APSC 171 Calculus I F | 3.3

- APSC 112 Physics II W | 3.3
  or
- APSC 114 Electricity and Magnetism W | 3.3
- APSC 132 Chemistry and its Applications W | 3.3
- APSC 162 Engineering Graphics W | 2.5
- APSC 172 Calculus II W | 3.3
- APSC 174 Introduction to Linear Algebra W, S | 3.3
- APSC 182 Applied Engineering Mechanics W, F, S | 1.7

Minimum Total Credits: 43.1

First Year Advice and Counseling

First Year students looking for academic advice and counseling are encouraged to contact the Program Associate, Student Services, Faculty of Engineering and Applied Science by phone at 533-2055 or by email at engineering.first.year@queensu.ca.

The Douglas Help Desk

A gift from Dr. James Douglas (Queen's BA, 1858) in 1910 made possible the establishment of a program by which First Year students are tutored by students selected from senior years. Details are available in the Faculty Office, and on the web at http://engineering.queensu.ca/Current-Students/First-Year-Studies/DouglasTutorials.html

The Engineering Society (EngSoc) Engvents

The EngSoc Engvents The Engvents Committee's mandate is to connect engineering students of all years and disciplines through team based competitions and social events hosted throughout the year. Past events have included paintballing, dodgeball tournaments, bowling nights, amazing race style scavenger hunts, and even a Boat Cruise on Lake Ontario! So come on out, connect with fellow engineers, and have a great time with Engvents! If you have any questions or would like to get involved with Engvents, contact engvents@engsoc.queensu.ca.

The Engineering Society (EngSoc) 'EngLinks' Tutoring System

For help using the EngSoc 'EngLinks' Tutoring System, see http://englinks.ca/

The Extended Program

The Extended Program provides an opportunity for First Year students who experience difficulties with the introductory courses APSC 111, APSC 131, and/or APSC 171 in the fall semester to retake these courses in the winter semester. Registration in the Extended Program takes place in early January. The courses normally completed in December are reviewed, and final examinations are rewritten in February during Reading Week. Instruction in the second term courses in APSC 112, APSC 132, APSC 172 and APSC 174 begins after Reading Week, is suspended when regular Winter term lectures end, and resumes after the normal examination period. These second term courses are completed in June. There is a special fee for each course in the Spring term (see the Section on Fees) *

Orientation Nights

In late January and early February each department holds an Orientation Night for first year students to introduce them to the department and to its academic plan(s). Students are encouraged to attend as many of these evening seminars as possible to help them make their plan choice. Help in reaching a decision regarding future studies can also be obtained in private discussions with upper year students, instructors, and the Program Associate, Student Services in the Faculty Office. Help is available on web pages maintained the departments in the Faculty (see http://engineering.queensu.ca/Current-Students/First-Year-Studies/DisciplineOrientationSchedule.html).

Choice of Program: Preregistration

First year students preregister in February to indicate the academic plan in which they intend to register in the academic year. A student will be admitted to the plan of their choice, provided the first year requirements have been met. Having preregistered in one plan, it may be possible to apply to transfer to another at a later date. However, such a change must be approved, in advance, by the department offering the academic plan in which the student wishes to register.

Admission to a Second Year Program

The rules governing the admission to the second year are given in the Faculty Regulations Section: in particular, Regulations 2f, 2g, and 10. Briefly, if a student has passed all of the courses in the First Year plan with marks of 1.6 ECGPA or better, admission to the second year will be unconditional. Otherwise, there may be constraints. Advice should be sought from the Faculty Office, or from the Chair of Undergraduate Studies in the program of choice.

Academic Plans

Chemical Engineering

Department Head B. Amsden
Undergraduate Chair M. Guay
Undergraduate Assistant L.D. Joanette
Office Dupuis Hall, Room 205
Telephone (613) 533-6000 Ext. 74829
E-mail undergrad@chee.queensu.ca
Departmental Web Site http://www.chemeng.queensu.ca

The Chemical Engineering academic plan provides students with a versatile engineering experience based on fundamental sciences, mathematics, and engineering science, combined with engineering design. Students may elect to pursue the Chemical Process Engineering Sub-plan (CHE1) or the Bioengineering - Biochemical, Biomedical, Bioenvironmental Sub-plan (CHE2). In addition to the technical content of the plan, students are introduced to business skills (engineering communication and ethics, innovation and entrepreneurship, process economics and project management) and acquire laboratory experience in state-of-the-art facilities. Group-based design projects are offered throughout the design spine. In their fourth year students select client-based industrial consulting projects, or research projects under the supervision of academic staff or professional engineers. All students have access to a computing facility, equipped with software programs and simulators.

Ancillary Fees

Chemical Engineering and Engineering Chemistry students may be required to pay ancillary fees for course related learning materials, safety equipment and field trips.

(CHE1) Chemical Engineering - Chemical Process Engineering Sub-Plan, B.A.Sc.(Class of 2022)

Second Year CORE 2019-2020

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 224 Transport Phenomena Fundamentals F | 3
- ENCH 211 Main Group Chemistry F | 4.75
- ENCH 212 Principles of Chemical Reactivity F | 4
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 4.75

Minimum Total Credits: 45

NOTE: CHEE 224 will not be offered in 2019-2020 only. Students will instead take MTHE 227.

Third Year CORE 2020-2021

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 331 Design of Unit Operations W | K4.5
- CHEE 361 Engineering Communications, Ethics & Professionalism W | K1
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- ELECTIVE - Complementary Studies (6 Credits) F/W | 6
- ELECTIVE - Technical Elective (Minimum 3 Credits) F/W | 3

Minimum Total Credits: 42.5

NOTE: It is recommended that students take APSC 221 during the fall term in preparation for CHEE 331 in the winter term.

NOTE: For the CHE1 Class of 2022 only, CHEE 323 has been moved to 4th year and a complementary study elective has been moved to 3rd year.

Fourth Year CORE 2021-2022

- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 471 Chemical Process Design FW | 7
- CHEE 412 Transport Phenomena W | 3.5
- ELECTIVE - Technical Elective (minimum 9 credits) F/W | 9
- ELECTIVE - Elective Complementary Studies (3 credits) F/W | 3

Plus One Of:

- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 410 Engineering Innovation and Entrepreneurship W | K4
  Plus a TECH Elective from either Group A or Group B[1]
  OR
- CHEE 420 Laboratory Projects III W | K4 Plus a TECH Elective from either Group A or Group B[2]
  OR
- CHEE 421 Research Project FW | K 7
  OR
- MINE 434 Project Report F/W | 4 Plus a TECH Elective from either Group A or Group B[3]

Minimum Total Credits: 36.5

[1] CHEE 410 plus a TECH elective from either Group A or Group B count together as one choice. This TECH elective is counted separate from the technical elective requirements of the program.

[2]CHEE 420 and a TECH elective from either Group A or Group B count together as one choice. *This TECH elective is counted separate from the technical elective requirements of the program.*

[3] MINE 434 and a TECH elective from either Group A or Group B count together as one choice. *This TECH elective is counted separate from the technical elective requirements of the program.*

Technical Electives

Students in the CHE1 Process Engineering sub-plan must take four (4) technical elective (TECH) courses - two (2) technical elective courses from the Technical Electives Group A list and two (2) courses from either the Technical Electives Group A or Technical Electives Group B list.

For students interested in a Minerals Processing/Metal Extraction focus the recommended course sequence is 1. MINE 267 (Winter term of 3rd year), 2. MINE 451 (Fall term of 4th year), and MINE 434 (Winter term of 4th year).

Chemical Process and Bioengineering Sub-plan: Technical Electives

Complementary Studies

Students choose a total of 9 credits from the approved Lists A or B, of which 3 credits must be taken from List A.

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take APSC 221 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 361 (these are CORE courses).

(CHE1) Chemical Engineering - Chemical Process Engineering Sub-Plan, B.A.Sc.(Class of 2023)

Second Year CORE 2020-2021

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 224 Transport Phenomena Fundamentals F | 3

- ENCH 211 Main Group Chemistry F | 4.75
- ENCH 212 Principles of Chemical Reactivity F | 4
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 4.75

Minimum Total Units: 45

Third Year CORE 2021-2022

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 331 Design of Unit Operations W | K4.5
- CHEE 361 Engineering Communications, Ethics & Professionalism W | K1
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- ELECTIVE - Technical Elective (Minimum 3 Credits) F/W | 3
- ELECTIVE - Complementary Studies (3 Credits) F/W | 3

Minimum Total Units: 43

Fourth Year CORE 2022-2023

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 412 Transport Phenomena W | 3.5
- CHEE 471 Chemical Process Design FW | 7
- ELECTIVE - Technical Elective (minimum 9 credits) F/W | 9
- ELECTIVE - Complementary Studies (6 credits) F/W | 6

Plus One Of:

- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 410 Engineering Innovation and Entrepreneurship W | K4 Plus a TECH Elective from either Group A or Group B[1]
  OR
- CHEE 420 Laboratory Projects III W | K4 Plus a TECH Elective from either Group A or Group B[2]
  OR
- CHEE 421 Research Project FW | K 7
  OR
- MINE 434 Project Report F/W | 4 Plus a TECH Elective from either Group A or Group B[3]

Minimum Total Credits: 36

[1] CHEE 410 *and a TECH elective from either Group A or Group B count together as one choice.* This technical elective is counted separate from the technical elective requirements of the program.

[2]*CHEE 420 and a TECH elective from either Group A or Group B count together as one choice.* This technical elective is counted separate from the technical elective requirements of the program.

[3] *MINE 434 and a TECH elective from either Group A or Group B count together as one choice.* This technical elective is counted separate from the technical elective requirements of the program.

Technical Electives

Students in the CHE1 Process Engineering sub-plan must take four (4) technical elective (TECH) courses - two (2) technical elective courses from the Technical Electives Group A list and two (2) courses from either the Technical Electives Group A or Technical Electives Group B list.

For students interested in a Minerals Processing/Metal Extraction focus the recommended course sequence is 1. MINE 267 (Winter term of 3rd year), 2. MINE 451 (Fall term of 4th year), and MINE 434 (Winter term of 4th year).

Chemical Process and Bioengineering Sub-plan: Technical Electives

Complementary Studies

Students choose a total of 9 credits from the approved Lists A or B, of which 3 credits must be taken from List A.

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take APSC 221 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 361 (these are CORE courses).

(CHE1) Chemical Engineering - Chemical Process Engineering Sub-Plan, B.A.Sc.(Class of 2024)

Second Year CORE 2021-2022

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 224 Transport Phenomena Fundamentals F | 3
- ENCH 211 Main Group Chemistry F | 4.75
- ENCH 212 Principles of Chemical Reactivity F | 4
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 4.75

Minimum Total Units: 45

Third Year CORE 2022-2023

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4

- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 331 Design of Unit Operations W | K4.5
- CHEE 361 Engineering Communications, Ethics & Professionalism W | K1
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- ELECTIVE - Complementary Studies (3 credits) F/W | 3
- ELECTIVE - Technical Elective (minimum 3 credits) F/W | 3

Minimum Total Units: 43

NOTE: It is recommended that students take APSC 221 during the fall term in preparation for CHEE 331 in the winter term.

Fourth Year CORE 2023-2024

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 471 Chemical Process Design FW | 7
- CHEE 412 Transport Phenomena W | 3.5
- ELECTIVE - Complementary Studies (6 credits) F/W | 6
- ELECTIVE - Technical Elective (minimum 9 credits) F/W | 9

Plus One Of:

- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 410 Engineering Innovation and Entrepreneurship W | K4
  Plus a TECH Elective from either Group A or Group B[1]
  OR
- CHEE 420 Laboratory Projects III W | K4 Plus a TECH Elective from either Group A or Group B[2]
  OR
- CHEE 421 Research Project FW | K 7
  OR
- MINE 434 Project Report F/W | 4 Plus a TECH Elective from either Group A or Group B[3]

Minimum Total Credits: 36

[1] *CHEE 410 plus a TECH elective from either Group A or Group B count together as one choice.* This technical elective is counted separate from the technical elective requirements of the program.

[2] *CHEE 420 and a TECH elective from either Group A or Group B count together as one choice.* This technical elective is counted separate from the technical elective requirements of the program.

[2] *MINE 434 and a TECH elective from either Group A or Group B count together as one choice.* This technical elective is counted separate from the technical elective requirements of the program.

Technical Electives

Students in the CHE1 Process Engineering sub-plan must take four (4) technical elective (TECH) courses - two (2) technical elective courses from the Technical Electives Group A list and two (2) courses from either the Technical Electives Group A or Technical Electives Group B list.

For students interested in a Minerals Processing/Metal Extraction focus the recommended course sequence is 1. MINE 267 (Winter term of 3rd year), 2. MINE 451 (Fall term of 4th year), and MINE 434 (Winter term of 4th year).

Chemical Process and Bioengineering Sub-plan: Technical Electives

Complementary Studies

Students choose a total of 9 credits from the approved Lists A or B, of which 3 credits must be taken from List A.

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take APSC 221 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 361 (these are CORE courses).

(CHE2) Bioengineering - Biochemical, Biomedical, Bioenvironmental Sub-Plan B.A.Sc. (2022)

Second Year CORE 2019-2020

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 229 Cell Based Engineering Principles F | 4
- ENCH 211 Main Group Chemistry F | 4.75
- ENCH 212 Principles of Chemical Reactivity F | 4
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 4.75

Minimum Total Credits: 46

Third Year CORE 2020-2021

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 331 Design of Unit Operations W | K4.5
- CHEE 340 Biomedical Engineering W | 3.5
- CHEE 361 Engineering Communications, Ethics & Professionalism W | K1
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- ELECTIVE - Complementary Studies (3 Credits) F/W | 3

Minimum Total Credits: 43.5

NOTE: It is recommended that students take APSC 221 during the fall term in preparation for CHEE 331 in the winter term.

Fourth Year CORE 2021-2022

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 452 Transport Phenomena in Physiological Systems F | 3.5
- CHEE 471 Chemical Process Design FW | 7
- ELECTIVE - Technical Elective (Minimum 9 Credits) F/W | 9
- ELECTIVE - Complementary Studies (6 Credits) F/W | 6

Plus One Of:

- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 408 Bioengineering Research Project FW | K7
  OR
- CHEE 410 Engineering Innovation and Entrepreneurship W | K4
  PLUS technical elective from either Group A or Group B[1]

Minimum Total Credits: 36

[1] CHEE 410 plus a technical elective from either Group A or Group B count together as one choice. This technical elective is counted separate from the technical elective requirements of the program.

Technical Electives

Students in the CHE2 Bioengineering - Biochemical, Biomedical, Bioenvironmental sub-plan take one technical elective (TECH) course from the Technical Electives Group A list and two (2) courses from either the Technical Electives Group A or Technical Electives Group B technical electives list. NOTE: Students in the Bioengineering option are encouraged to select electives from the relevant elective groupings.

Chemical Process and Bioengineering Sub-plan: Technical Electives

Complementary Studies

Students choose a total of 9 credits from the approved Lists A or B, of which 3 credits must be taken from List A.

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take APSC 221 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 361 (these are CORE courses).

(CHE2) Bioengineering - Biochemical, Biomedical, Bioenvironmental Sub-Plan B.A.Sc. (2023)

Second Year CORE 2020-2021

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 229 Cell Based Engineering Principles F | 4
- ENCH 211 Main Group Chemistry F | 4.75
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- ENCH 212 Principles of Chemical Reactivity F | 4
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 4.75

Minimum Total Credits: 46

Third Year CORE 2021-2022

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5

- CHEE 315 Laboratory Projects II F/W | 4
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 331 Design of Unit Operations W | K4.5
- CHEE 340 Biomedical Engineering W | 3.5
- CHEE 361 Engineering Communications, Ethics & Professionalism W | K1
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- ELECTIVE - Complementary Studies (3 Credits) F/W | 3

Minimum Total Credits: 43.5

NOTE: It is recommended that students take APSC 221 during the fall term in preparation for CHEE 331 in the winter term.

Fourth Year CORE 2022-2023

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 452 Transport Phenomena in Physiological Systems F | 3.5
- CHEE 471 Chemical Process Design FW | 7
- ELECTIVE - Technical Elective (Minimum 9 Credits) F/W | 9
- ELECTIVE - Complementary Studies (6 Credits) F/W | 6

Plus One Of:

- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR
- CHEE 408 Bioengineering Research Project FW | K7
  OR
- CHEE 410 Engineering Innovation and Entrepreneurship W | K4
  Plus a TECH elective from either Group A or Group B[1]

Minimum Total Credits: 36

[1] CHEE 410 and a TECH elective from either Group A or Group B count together as one choice. This technical elective is counted separate from the technical elective requirements of the program.

Technical Electives

Students in the CHE2 Bioengineering - Biochemical, Biomedical, Bioenvironmental sub-plan take one technical elective (TECH) course from the Technical Electives Group A list and two (2) courses from either the Technical Electives Group A or Technical Electives Group B technical electives list. NOTE: Students in the Bioengineering option are encouraged to select electives from the relevant elective groupings.

Chemical Process and Bioengineering Sub-plan: Technical Electives

Complementary Studies

Students choose a total of 9 credits from the approved Lists A or B, of which 3 credits must be taken from List A.

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take APSC 221 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 361 (these are CORE courses).

(CHE2) Bioengineering - Biochemical, Biomedical, Bioenvironmental Sub-Plan B.A.Sc. (2024)

Second Year CORE 2021-2022

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 229 Cell Based Engineering Principles F | 4
- ENCH 211 Main Group Chemistry F | 4.75
- ENCH 212 Principles of Chemical Reactivity F | 4
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CHEE 218 Laboratory Projects I W | 2.5

- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 245 Applied Organic Chemistry I W | 4.75

Minimum Total Credits: 46

Third Year CORE 2022-2023

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 315 Laboratory Projects II F/W | 4
- CHEE 319 Process Dynamics and Control W | 3.5
- CHEE 331 Design of Unit Operations W | K4.5
- CHEE 340 Biomedical Engineering W | 3.5
- CHEE 361 Engineering Communications, Ethics & Professionalism W | K1
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- ELECTIVE - Complementary Studies (3 Credits) F/W | 3

Minimum Total Credits: 43.5

NOTE: It is recommended that students take APSC 221 during the fall term in preparation for CHEE 331 in the winter term.

Fourth Year CORE 2023-2024

- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 452 Transport Phenomena in Physiological Systems F | 3.5
- CHEE 471 Chemical Process Design FW | 7
- ELECTIVE - Technical Elective (Minimum 9 Credits) F/W | 9
- ELECTIVE - Complementary Studies (6 Credits) F/W | 6

Plus One Of:

- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7
  OR
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
  OR

- CHEE 408 Bioengineering Research Project FW | K7
  OR
- CHEE 410 Engineering Innovation and Entrepreneurship W | K4
  PLUS a technical elective from either Group A or Group B[1]

Minimum Total Credits: 36

[1] CHEE 410 plus a technical elective from either Group A or Group B count together as one choice. This technical elective is counted separate from the technical elective requirements of the program.

Technical Electives

Students in the CHE2 Bioengineering - Biochemical, Biomedical, Bioenvironmental sub-plan take one technical elective (TECH) course from the Technical Electives Group A list and two (2) courses from either the Technical Electives Group A or Technical Electives Group B technical electives list. NOTE: Students in the Bioengineering option are encouraged to select electives from the relevant elective groupings.

Chemical Process and Bioengineering Sub-plan: Technical Electives

Complementary Studies

Students choose a total of 9 credits from the approved Lists A or B, of which 3 credits must be taken from List A.

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics

To meet the engineering economics requirement, students take APSC 221 (this is a CORE course).

Communications

To meet the communications course requirement, students take APSC 293 and CHEE 361 (these are CORE courses).

Chemical Process and Bioengineering Sub-plan: Technical Electives

Should a course on the list below already be a core course for a sub-plan, then that course is excluded as an elective for that sub-plan. For example ...

• CHEE 340 and CHEE 342 are core courses for the CHE2 sub-plan and thus cannot be counted as electives.

• CHEE 323 is a core course for the CHE1 sub-plan and thus cannot be counted as an elective.

• APSC 250 has CHEE 229 as an exclusion (a core course taken by CHE2) and thus cannot be counted as an elective.

PLEASE NOTE: Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

PLEASE NOTE: Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

TECHNICAL ELECTIVES

Should a course on the technical elective list already be a core course for a sub-plan, then that course is excluded as an elective for that sub-plan. For example ...

- CHEE 340 and CHEE 342 are core courses for the CHE2 sub-plan and thus cannot be counted as electives.
- CHEE 323 is a core course for the CHE1 sub-plan and thus cannot be counted as an elective.
- APSC 250 has CHEE 229 as an exclusion (a core course taken by CHE2) and thus cannot be counted as an elective.

APSC 303 counts as a Group A Technical Elective upon successful completion of internship.

PLEASE NOTE: Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

PLEASE NOTE: Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

GROUP A TECHNICAL ELECTIVES

Biomedical

- CHEE 340 Biomedical Engineering W | 3.5
- CHEE 440 Pharmaceutical Technology W | 3.5
- MECH 393 Biomechanical Product Development W | 3.5
- MECH 492 Biological Fluid Dynamics F | 3.5

Energy, Energy Resources, and Petroleum Engineering

- CHEE 270 ChemEtronics F | K3
- CHEE 363 Electrochemical Engineering* W | 3.5
- CHEE 414 Foundations of the Oil and Gas Industry W | K3.5
- MECH 430 NOT OFFERED 2021-2022 - Thermal Systems Design W | 4
- MECH 435 Internal Combustion Engines F | 3.5
- MECH 437 Fuel Cell Technology F | 3.5
- MECH 439 Turbomachinery W | 3.5

Environmental

- CHEE 342 Environmental Biotechnology F | 3.5
- CHEE 484 NOT OFFERED 2021-2022 Bioremediation W | 3.5
- CIVL 371 Groundwater Engineering F | 3.75
- CIVL 372 Water and Wastewater Engineering W | 4
- CIVL 451 Lake, Reservoir and Coastal Engineering F | 3.75
- CIVL 471 Subsurface Contamination F | 4

Materials Processing

- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 324 NOT OFFERED 2021-2022 Organic Process Development W | 3.5
- CHEE 460 Applied Surface and Colloid Science F | 3.5
- CHEE 490 Polymer Formulations and Processing Technology W | 3.5
- MECH 270 Materials Science and Engineering F | 3.5
- MECH 370 Principles of Materials Processing F | 3.5
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5

Minerals Processing

- MINE 267 Applied Chemistry for Mining W | 3.5
- MINE 331 Methods of Mineral Separation F | 4.5
- MINE 335 Mineral Processing F | 3

- MINE 451 Chemical Extraction of Metals F | 4
- MNTC 306 Mineral Processing Unit Operations O/L | 3
- MNTC 311 Ore Body Modelling and Resource Estimation O/L | 4.5
- MNTC 415 Metal Extraction Processes O/L | 4

Process Automation, Applied Mathematics & Modeling

- CHEE 434 Process Control II W | 3.5
- ELEC 278 Fundamentals of Information Structures F | 4
- MECH 480 Airplane Aerodynamics and Performance W | 3.5

General

- APSC 303 Professional Internship | 3.5
- APSC 381 Advanced Design and Skills for Innovation W | K3.5
- APSC 401 Interdisciplinary Projects W | K4.5

GROUP B TECHNICAL ELECTIVES

Applied Chemistry

- ENCH 213 Introduction to Chemical Analysis F | 4.75
- ENCH 222 Methods of Structure Determination W | 3.75
- ENCH 311 Mechanistic Organic Chemistry F | 3.5
- ENCH 312 Transition Metal Chemistry F | 3.5
- ENCH 326 Environmental and Green Chemistry W | 3
- ENCH 411 Advanced Analytical Chemistry F | 3
- ENCH 422 Synthetic Organic Chemistry W | 3.5
- ENCH 424 NOT OFFERED 2021-2022 Polymer Chemistry W | 3

Applied Mathematics & Statistics

- MTHE 339 Evolutionary Game Theory W | 3

Biosciences

- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- BCHM 315 Proteins and Enzymes F | 3
- BIOL 335 Limnology and Aquatic Ecology F | 3
- BIOM 300 NOT OFFERED 2021-2022 - Modeling Techniques in Biology F | 3
- ENCH 323 Biological Chemistry W | 3

Energy Resources/Petroleum Engineering

- GEOE 238 Surficial Processes, Sedimentation and Stratigraphy W | 4

Civil Engineering

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4th Year Advisor Y. Fillion

Civil Engineering focuses on the analysis, design, and improvement of the human environment—both natural and constructed. Our students will learn how the world works and will provide improvements in the overall quality of life, make better use of limited resources, develop sustainable technologies, and create attractive and functional places to live and work.

Civil Engineering at Queen's University prepares students to identify emerging issues and develop innovative solutions to the numerous civil engineering, societal, and global challenges of the future.

The core undergraduate curriculum covers the key components of today's Civil Engineering professions. The study of environmental and sustainability issues is integrated throughout the academic plan to better reflect that the assessment of these concerns is integral to all civil engineering projects. The first three years of our plan provide broad-based training in: mathematics; science (physics, chemistry & geology); fluid, structural and soil mechanics; materials (water, concrete, steel, soil & plastics); and engineering problem solving & design. Students in their fourth year are able to either specialize in an area of interest, or further diversify their training. Specialization can be under the themes of buildings & structures, water & the environment, or geoengineering. This student choice arises in the selection of: technical electives, topics for realistic design projects, areas to conduct advanced research, and practical industrial internships.

Civil Engineering, B.A.Sc. (Class of 2022)

Second Year CORE 2019-2020

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3

- APSC 293 Engineering Communications l F/W | K1
- CIVL 200 Professional Skills I F | 2.5
- CIVL 210 Chemistry for Civil Engineers F | 4.5
- CIVL 215 Materials for Civil Engineers W | 4.5
- CIVL 222 Numerical Methods for Civil Engineers W | 5
- CIVL 230 Solid Mechanics I F | 4.25
- CIVL 231 Solid Mechanics II W | 4.5
- CIVL 250 Hydraulics I W | 4
- MTHE 224 Applied Mathematics for Civil Engineers F | 4.2
- Complementary Studies - List A F | 3

Minimum Total Credits: 44.45

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Third Year CORE 2020-2021

- CIVL 300 Professional Skills II F | K 2.5
- CIVL 330 Structural Analysis F | 3.75
- CIVL 340 Geotechnical Engineering I F | 3.75
- CIVL 350 Hydraulics II F | 3.75
- CIVL 371 Groundwater Engineering F | 3.75
- CIVL 331 Structural Steel Design W | 4
- CIVL 341 Geotechnical Engineering II W | 4
- CIVL 360 Civil Engineering Design and Practice III W | K4
- CIVL 372 Water and Wastewater Engineering W | 4
- Complementary Studies - List A F | 3
- Complementary Studies - List B W | 3

Minimum Total Credits: 39.5

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Fourth Year CORE 2021-2022

- CIVL 400 Professional Skills III F | 2.5
- CIVL 460 Civil Engineering Design and Practice IV FW | K6
- Complementary Studies - List A or B F | 3
- Electives F&W   25.75

Minimum Total Credits: 37.25

Electives

All students must choose EIGHT Electives, *at least SIX of which must be Technical Electives from List 1 shown below.* The SEVENTH Elective may be from List 1 or List 2 shown below. The **EIGHTH** Elective may be from List 1 or List 2 or a Free Elective - see course list below.

Civil Engineering: Technical Electives

A Free Elective can be any of the following courses with a minimum of 3 credits:

- Any 3 credit course appearing anywhere in the Applied Science calendar, in the course descriptions list, in the requirements for any academic plan, or in the lists of eligible complementary studies courses
- Any course at the 100 level or higher from the Arts and Science calendar with any of the following subject codes: ANAT, BCHM, BIOL, CDNS, CHEM, CISC,COGS, COMM, DEVS, GEOL, GIMS, GISC, GISQ, GPHY, HLTH, IDIS, INTS, ENSC,EPID, LING, MATH, MICR, PHAR, PHYS, PHGY, STSC, STAT, WRIT
- Any of the graduate courses offered in Urban and Regional Planning

Free Electives must be approved by the Undergraduate Chair, please contact the Undergraduate Program Assistant.

*APSC 480: Units will not count towards the requirements of taking at least six Technical Electives from List 1 but because of the number of units, they will count towards a Technical Elective, List 2 and Free Elective.

***APSC 303 can count as a Free Elective (3.5 units) for students who have successfully completed a Queen's Undergradate Internship Program (QUIP).**

Civil Engineering, B.A.Sc. (Class of 2023)

Second Year CORE 2020-2021

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- APSC 293 Engineering Communications l F/W | K1
- CIVL 200 Professional Skills I F | 2.5
- CIVL 210 Chemistry for Civil Engineers F | 4.5
- CIVL 215 Materials for Civil Engineers W | 4.5
- CIVL 222 Numerical Methods for Civil Engineers W | 5
- CIVL 230 Solid Mechanics I F | 4.25
- CIVL 231 Solid Mechanics II W | 4.5
- CIVL 250 Hydraulics I W | 4

- MTHE 224 Applied Mathematics for Civil Engineers F | 4.2
- Complementary Studies- Humanities & Social Sciences List A F | 3

Minimum Total Credits: 44.45

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Third Year CORE 2021-2022

- CIVL 300 Professional Skills II F | K 2.5
- CIVL 330 Structural Analysis F | 3.75
- CIVL 331 Structural Steel Design W | 4
- CIVL 340 Geotechnical Engineering I F | 3.75
- CIVL 341 Geotechnical Engineering II W | 4
- CIVL 350 Hydraulics II F | 3.75
- CIVL 360 Civil Engineering Design and Practice III W | K4
- CIVL 371 Groundwater Engineering F | 3.75
- CIVL 372 Water and Wastewater Engineering W | 4
- Complementary Studies - Humanities & Social Sciences List A F | 3
- Complementary Studies - Linkage and Professional Issues List B W | 3

Minimum Total Credits: 39.5

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Fourth Year CORE 2022-2023

- CIVL 400 Professional Skills III F | 2.5
- CIVL 460 Civil Engineering Design and Practice IV FW | K6
- Complementary Studies- List A or B F | 3
- Electives F&W | 25.75

Minimum Credits: 37.25

Electives

All students must choose EIGHT Electives, **at least SIX of which must be Technical Electives from List 1 shown below.** The SEVENTH Elective may be from List 1 or List 2 shown below. The EIGHTH Elective may be from List 1 or List 2 or a Free Elective - see course list below.

Civil Engineering: Technical Electives

A Free Elective can be any of the following courses with a minimum of 3 credits

- Any 3 credit course appearing anywhere in the Applied Science calendar, in the course descriptions list, in the requirements for any academic plan, or in the lists of eligible complementary studies courses
- Any course at the 100 level or higher from the Arts and Science calendar with any of the following subject codes: ANAT, BCHM, BIOL, CDNS, CHEM, CISC,COGS, COMM, DEVS, GEOL, GIMS, GISC, GISQ, GPHY, HLTH, IDIS, INTS, ENSC,EPID, LING, MATH, MICR, PHAR, PHYS, PHGY, STSC, STAT, WRIT
- Any of the graduate courses offered in Urban and Regional Planning

Free Electives must be approved by the Undergraduate Chair, please contact the Undergraduate Program Assistant.

*APSC 480: Units will not count towards the requirements of taking at least six Technical Electives from List 1 but because of the number of units, they will count towards a Technical Elective, List 2 and a Free Elective.

***APSC 303 can count as a Free Elective (3.5 units) for students who have successfully completed a Queen's Undergradate Internship Program (QUIP).**

Civil Engineering, B.A.Sc. (Class of 2024)

Second Year CORE 2021-2022

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- APSC 293 Engineering Communications l F/W | K1
- CIVL 200 Professional Skills I F | 2.5
- CIVL 210 Chemistry for Civil Engineers F | 4.5
- CIVL 215 Materials for Civil Engineers W | 4.5
- CIVL 222 Numerical Methods for Civil Engineers W | 5
- CIVL 230 Solid Mechanics I F | 4.25
- CIVL 231 Solid Mechanics II W | 4.5
- CIVL 250 Hydraulics I W | 4
- MTHE 224 Applied Mathematics for Civil Engineers F | 4.2
- Complementary Studies- Humanities & Social Sciences List A F | 3

Minimum Credits: 44.45

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Third Year CORE 2022-2023

- CIVL 300 Professional Skills II F | K 2.5
- CIVL 330 Structural Analysis F | 3.75
- CIVL 331 Structural Steel Design W | 4
- CIVL 340 Geotechnical Engineering I F | 3.75
- CIVL 341 Geotechnical Engineering II W | 4
- CIVL 350 Hydraulics II F | 3.75
- CIVL 360 Civil Engineering Design and Practice III W | K4
- CIVL 371 Groundwater Engineering F | 3.75
- Complementary Studies – Humanities & Social Sciences List A F | 3
- CIVL 372 Water and Wastewater Engineering W | 4
  Complementary Studies - Linkage and Professional Issues List B W | 3

Minimum Credits: 39.5

Note: A minimum of 6 credits must be taken from Complementary Studies List A.

Fourth Year CORE 2023-2024

- CIVL 400 Professional Skills III F | 2.5
- CIVL 460 Civil Engineering Design and Practice IV FW | K6
  Complementary Studies- List A or B F | 3
- Electives F&W | 25.75

Minimum Credits: 37.25

Electives

All students must choose EIGHT Electives, **at least SIX of which must be Technical Electives from List 1 shown below.** The SEVENTH Elective may be from List 1 or List 2 shown below. The EIGHTH Elective may be from List 1 or List 2 or a Free Elective - see course list below.

Civil Engineering: Technical Electives

A Free Elective can be any of the following courses with a minimum of 3 credits:

- Any 3 credit course appearing anywhere in the Applied Science calendar, in the course descriptions list, in the requirements for any academic plan, or in the lists of eligible complementary studies courses
- Any course at the 100 level or higher from the Arts and Science calendar with any of the following subject codes: ANAT, BCHM, BIOL, CDNS, CHEM, CISC,COGS, COMM,

DEVS, GEOL, GIMS, GISC, GISQ, GPHY, HLTH, IDIS, INTS, ENSC,EPID, LING, MATH, MICR, PHAR, PHYS, PHGY, STSC, STAT, WRIT

- Any of the graduate courses offered in Urban and Regional Planning

Free Electives must be approved by the Undergraduate Chair, please contact the Undergraduate Program Assistant.

*APSC 480 : Units will not count towards the requirements of taking at least six Technical Electives from List 1 but because of the number of units, they will count towards a Technical Elective, List 2 and Free Elective.

***APSC 303 can count as a Free Elective (3.5 units) for students who have successfully completed a Queen's Undergraduate Internship Program (QUIP).**

Civil Engineering: Technical Electives

Technical Electives List 1

- CIVL 430 Reinforced Concrete Design F | 3.75
- CIVL 442 Geotechnical Design F | 3.75
- CIVL 450 Municipal Hydraulics F | 3.75
- CIVL 451 Lake, Reservoir and Coastal Engineering F | 3.75
- CIVL 472 Water Treatment W | 3.75
- CIVL 473 Water Resources System W | 3.75
- CIVL 431 Infrastructure Rehabilitation W | 4
- CIVL 436 Prestressed Concrete W | 4
- CIVL 443 Geoenvironmental Design W | 4
- CIVL 455 River Engineering F | 4
- CIVL 471 Subsurface Contamination F | 4
- CIVL 500 Civil Engineering Thesis FW | K4

Technical Electives List 2

- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- APSC 381 Advanced Design and Skills for Innovation W | K3.5
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 484 NOT OFFERED 2021-2022 Bioremediation W | 3.5
- GEOE 313 Engineering Geology and Geomechanics W | 3.5
- GEOE 333 Terrain Evaluation W | 4
- GEOE 414 Foundations of the Oil and Gas Industry W | 3.5
- MECH 230 Applied Thermodynamics I F | 3.5

- MECH 341 Fluid Mechanics II W | 3.5
- MECH 346 Heat Transfer W | 3.5
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 394 Frontiers in Biomechanical Engineering F | 3.5
- MECH 424 NOT OFFERED 2021-2022 - Sustainable Product Design F | 3.5
- MECH 444 NOT OFFERED 2021-2022 - Computational Fluid Dynamics W | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5
- MINE 201 Introduction to Mining and Mineral Processing F | 4
- MINE 272 Applied Data Science W | 4.5
- MINE 321 Drilling and Blasting F | 4.5
- MINE 324 Hydraulics for Mining Applications W | 3.5
- MINE 339 Mine Ventilation F | 4.5
- MINE 422 Mining and Sustainability F | 4
- MINE 459 Risk and Reliability Analysis for Industrial Asset Management, Health & Safety F | 4
- MINE 472 Not Offered 2021-2022 Mining Systems, Automation, and Robotics O/L | K3.5
- MNTC P07 Surveying Principles O/L | 3
- MNTC 314 Drilling and Blasting O/L | 4
- MNTC 408 Mine Health and Safety O/L | 3
- MNTC 418 Sustainability and the Environment O/L | 3
- MNTC 423 Geomatics O/L | 3
- SURP 855 Environmental Planning and Management W | 3
- SURP 853 Environmental Services W | 3

Computer Engineering

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Computer Engineers deal with the architecture, design, implementation, and verification of the hardware and software for computing systems that are increasingly being used in embedded or networked environments. The Computer Engineering plan offers a broad range of supporting course material to prepare graduates for entry into the profession. In the hardware area, courses cover digital logic and digital systems engineering, computer organization and system architecture, microprocessors, and integrated circuit engineering. Software courses include programming languages, data structures and algorithms, operating systems, real-time software design, databases, compilers, software requirements analysis, formal methods in software engineering, and techniques for human-computer interaction. Computer communication network courses include material on reliable and secure information transfer protocols, switching and routing through multipath networks, and wireless networking.

The Computer Engineering plan is "streamed". Through choice of elective courses in third and fourth year, students can either focus their studies in one or more areas of specialization ("streams"), or pursue a broader coverage of the subject field. Streams are detailed on the Departmental web pages.

First Year courses in Computer Science (APSC 142), Mathematics (APSC 171, APSC 172 and APSC 174), Engineering Practice (APSC 100) and Physics (APSC 112) form the basis for further study in Computer Engineering. Good performance is advisable for students planning to enter this academic plan.

Computer Engineering, B.A.Sc. (Class of 2022)

Elective courses in years three and four are to be chosen from Electives Lists A, B, and C, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 four-hundred level elective courses.
3. Have at least 4 courses from Electives Lists A, B, and C that satisfy the Department criteria for qualified accreditation units in the categories of engineering science and engineering design.
4. Have at least 3 courses from Elective List B.
5. Counting required core courses and elective courses in all four years, result in a total of no fewer than 157.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2019-2020

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 279 Introduction to Object Oriented Programming W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- Complementary Studies, List A F | 3

Total Credits: 44.75

Third Year CORE 2020-2021

- CMPE 365 Algorithms I F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 373 Computer Networks W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 390 Principles of Design and Development W | K3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CMPE 223 Software Specifications W | 3
  OR
- CMPE 320 Fundamentals of Software Development F | 4
- Technical Electives (choose 2) F/W | 6
- Complementary Studies F/W 3

Total Credits: 41.75 or 42.75

Fourth Year CORE 2021-2022

- ELEC 498 Computer Engineering Project FW | K7 *
- Technical Electives F/W | 17.1 or 18.1
- Complementary Studies F/W 3

Minimum Total Credits: 27.1 or 28.1

* with Departmental and instructor support, students may request to substitute APSC 480 Multi-disciplinary Industry for ELEC 498 Computer Engineering Project.

Electives

Computer Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Computer Engineering Program, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 (communications units are also included inside course ELEC 498).

Computer Engineering, B.A.Sc. (Class of 2023)

Elective courses in years three and four are to be chosen from Electives Lists A, B, and C, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 four-hundred level elective courses.
3. Have at least 4 courses from Electives Lists A, B and C that satisfy the Department criteria for qualified accreditation units in the categories of engineering science and engineering design.
4. Have at least 3 courses from Elective List B.
5. Counting required core courses and elective courses in all four years, result in a total of no fewer than 157.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2020-2021

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 279 Introduction to Object Oriented Programming W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
  or
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5

Minimum Total Credits: 44.75

Third Year CORE 2021-2022

- CMPE 365 Algorithms I F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 373 Computer Networks W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 390 Principles of Design and Development W | K3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CMPE 223 Software Specifications W | 3
  or
- CMPE 320 Fundamentals of Software Development F | 4
- Technical Electives (choose 1) F/W | 3
- Complementary Studies F/W | 3

Total Credits: 38.75 or 39.75

Fourth Year CORE 2022-2023

- ELEC 498 Computer Engineering Project FW | K7 *
- Technical Electives F/W | 20.1 or 21.1
- Complementary Studies F/W | 3

Minimum Total Credits: 30.1 or 31.1

* with Departmental and instructor support, students may request to substitute APSC 480 for ELEC 498

Electives

Computer Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Computer Engineering Plan, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 (communications units are also included inside course ELEC 498).

Computer Engineering, B.A.Sc. (Class of 2024)

Elective courses in years three and four are to be chosen from Electives Lists A, B, and C, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 four-hundred level elective courses.
3. Have at least 4 courses from Electives Lists A, B and C that satisfy the Department criteria for qualified accreditation units in the categories of engineering science and engineering design.
4. Have at least 3 courses from Elective List B.
5. Counting required core courses and elective courses in all four years, result in a total of no fewer than 157.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2021-2022

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 279 Introduction to Object Oriented Programming W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5

- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
  or
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- Complementary Studies, List A F | 3

Total Credits: 44.75

Third Year CORE 2022-2023

- CMPE 365 Algorithms I F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 373 Computer Networks W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 390 Principles of Design and Development W | K3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CMPE 223 Software Specifications W | 3
  or
- CMPE 320 Fundamentals of Software Development F | 4
- Technical Electives (choose 1) F/W | 3
- Complementary Studies F/W/S | 3

Total Credits: 38.75 or 39.75

Fourth Year CORE 2023-2024

- ELEC 498 Computer Engineering Project FW | K7 *
- Technical Electives F/W | 21.1 or 20.1
- Complementary Studies, F/W | 3

Minimum Total Credits: 30.1 or 31.1

* with Departmental and instructor support, students may request to substitute APSC 480 for ELEC 498

Electives

Computer Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Computer Engineering Program, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 (communications units are also included inside course ELEC 498).

Computer Engineering, ECEi Stream, B.A.Sc. (Class of 2022)

Elective courses in years three and four are to be chosen from Electives Lists A, B, and C, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 four-hundred level elective courses.
3. Have at least 4 courses from Electives Lists A, B and C that satisfy the Department criteria for qualified accreditation units in the categories of engineering science and engineering design.
4. Have at least 3 courses from Elective List B.
5. Counting required core courses and elective courses in all four years, result in a total of no fewer than 160.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2019-2020

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 279 Introduction to Object Oriented Programming W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5

- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- COMM 201 Introduction to Business for Entrepreneurs F | 3

Minimum Total Credits: 44.75

Third Year CORE 2020-2021

- CMPE 365 Algorithms I F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 373 Computer Networks W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 390 Principles of Design and Development W | K3.5
- CMPE 223 Software Specifications W | 3
  OR
- CMPE 320 Fundamentals of Software Development F | 4
- COMM 301 Funding New Ventures F |3
- COMM 302 Launching New Ventures W |3
- Technical Electives (choose 2) F/W | 6
- Complementary Studies List A F/W | 3

Minimum Total Credits: 44.75 or 45.75

Fourth Year CORE 2021-2022

- ELEC 498 Computer Engineering Project FW | K7 *
- COMM 405 New Business Development F | 3
- Technical Electives F/W | 18.1 or 17.1

Minimum Total Credits: 28.1 or 27.1

- with Departmental and instructor support, students may request to substitute APSC 480 Multi-disciplinary Industry for ELEC 498 Computer Engineering Project.

Electives

Computer Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

ECEi students are required to take a total of four Complementary Studies courses over 2nd, 3rd and 4th year: one elective Complementary Studies course from List A (Humanities and Social Sciences) and the required three courses COMM 301, COMM 302, COMM 405.

Computer Engineering, ECEi Stream, B.A.Sc. (Class of 2023)

Elective courses in years three and four are to be chosen from Electives Lists A, B, and C, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 four-hundred level elective courses.
3. Have at least 4 courses from Electives Lists A, B and C that satisfy the Department criteria for qualified accreditation units in the categories of engineering science and engineering design.
4. Have at least 3 courses from Elective List B.
5. Counting required core courses and elective courses in all four years, result in a total of no fewer than 160.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2020-2021

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 279 Introduction to Object Oriented Programming W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5

- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
  or
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- COMM 201 Introduction to Business for Entrepreneurs F | 3

Minimum Total Credits: 44.75

Third Year CORE 2021-2022

- CMPE 365 Algorithms I F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 373 Computer Networks W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 390 Principles of Design and Development W | K3.5
- CMPE 223 Software Specifications W | 3
  or
- CMPE 320 Fundamentals of Software Development F | 4
- COMM 301 Funding New Ventures S | 3
- COMM 302 Launching New Ventures W | 3
- Technical Electives (choose 1) F/W | 3
- Complementary Studies List A F/W/S | 3

Minimum Total Credits: 41.75 or 42.75

Fourth Year CORE 2022-2023

- ELEC 498 Computer Engineering Project FW | K7 *
- COMM 405 New Business Development F | 3
- Technical Electives F/W | 21.1 or 20.1

Minimum Total Credits: 31.1 or 30.1

* with Departmental and instructor support, students may request to substitute APSC 480 for ELEC 498

Electives

Computer Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

ECEi students are required to take a total of four Complementary Studies courses over 2nd, 3rd and 4th year: one elective Complementary Studies course from List A (Humanities and Social Sciences) and the required three courses COMM 301, COMM 302 and COMM 405.

Computer Engineering, ECEi Stream, B.A.Sc. (Class of 2024)

Elective courses in years three and four are to be chosen from Electives Lists A, B, and C, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 four-hundred level elective courses.
3. Have at least 4 courses from Electives Lists A, B and C that satisfy the Department criteria for qualified accreditation units in the categories of engineering science and engineering design.
4. Have at least 3 courses from Elective List B.
5. Counting required core courses and elective courses in all four years, result in a total of no fewer than 160.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2021-2022

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 279 Introduction to Object Oriented Programming W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5

or

- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- COMM 201 Introduction to Business for Entrepreneurs F | 3

Minimum Total Credits: 44.75

Third Year CORE 2022-2023

- CMPE 365 Algorithms I F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 373 Computer Networks W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 390 Principles of Design and Development W | K3.5
- CMPE 223 Software Specifications W | 3
  OR
- CMPE 320 Fundamentals of Software Development F | 4
- COMM 301 Funding New Ventures F | 3
- COMM 302 Launching New Ventures W | 3
- Technical Electives (choose 1) F/W | 3
- Complementary Studies List A F/W/S | 3

Minimum Total Credits: 41.75 or 42.75

Fourth Year CORE 2023-2024

- ELEC 498 Computer Engineering Project FW | K7 *
- COMM 405 New Business Development F | 3
- Technical Electives F/W | 21.1 or 20.1

Minimum Total Credits: 31.1 or 30.1

* with Departmental and instructor support, students may request to substitute APSC 480 for ELEC 498

Electives

Computer Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

ECEi students are required to take a total of four Complementary Studies courses over 2nd, 3rd and 4th year: one elective Complementary Studies course from List A (Humanities and Social Sciences) and the required three courses COMM 301, COMM 302 and COMM 405.

Computer Engineering: Electives

Electives List A

- ELEC 224 Continuous-Time Signals and Systems W | 3.75
- ELEC 324 Discrete-Time Signals and Systems F | 4
- ELEC 344 Sensors and Actuators F | 3.75
- ELEC 353 Electronics II F | 4.25
- ELEC 372 Numerical Methods and Optimization W | 3.5
- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- ELEC 409 Bioinformatic Analytics F | 3
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 422 NOT OFFERED 2021-2022 Digital Signal Processing: Random Models and Applications F | 3.5
- ELEC 425 Machine Learning and Deep Learning F | 3.5
- ELEC 431 Power Electronics F | 3.25
- ELEC 443 Linear Control Systems F | 4.25
- ELEC 444 NOT OFFERED 2021-2022 Modeling and Computer Control of Mechatronic Systems W | 3.25
- ELEC 448 Introduction to Robotics: Mechanics and Control F | 3.5
  or
- MECH 456 Introduction to Robotics F | 3.5
- ELEC 451 Digital Integrated Circuit Engineering F | 3.25
- ELEC 461 NOT OFFERED 2021-2022 Digital Communications F | 3.5
- ELEC 464 Wireless Communications F | 3
- ELEC 470 Computer System Architecture W | 3.5
- ELEC 472 Artificial Intelligence W | 3.5
- ELEC 473 Cryptography and Network Security F | 3
- ELEC 474 Machine Vision F | 3.5

- ELEC 497 Research Project FW/S | K3.5
- SOFT 423 Software Requirements W | 3
- SOFT 437 Performance Analysis W | 3

Electives List B

- CMPE 204 Logic for Computing Science F/W | 3
- CMPE 251 Data Analytics F | 3
- CMPE 320 Fundamentals of Software Development F | 4
- CMPE 322 Software Architecture W | 4
- CMPE 325 Human-Computer Interaction W | 3
- CMPE 327 Software Quality Assurance F | 3
- CMPE 332 Database Management Systems W | 3
- CMPE 351 Advanced Data Analytics W | 3
- CMPE 422 Formal Methods in Software Engineering F | 3
- CMPE 425 NOT OFFERED 2021-2022 Advanced User Interface Design W | 3
- CMPE 432 NOT OFFERED 2021-2022 Advanced Database Systems F | 3
- CMPE 434 NOT OFFERED 2021-2022 Distributed Systems F | 3
- CMPE 452 Neural Networks and Genetic Algorithms F | 3
- CMPE 454 Computer Graphics W | 3
- CMPE 457 Image Processing and Computer Vision F | 3
- CMPE 458 Programming Language Processors W | 4
- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- ENPH 336 Solid State Devices W | 3.25

Electives List C

- APSC 303 Professional Internship | 3.5
- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7
- APSC 401 Interdisciplinary Projects W | K4.5

Electrical Engineering

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Electrical Engineers deal with telecommunications, computers, electronics, signal processing, robotics, biomedicine, transportation, industrial process control, electrical power generation and distribution, and design and operation of industrial machinery. The Electrical Engineering plan is intended to prepare graduates for entry into this broad discipline. Fundamental courses in electric and electronic circuits, electromagnetics, signals and systems, applied mathematics, and other topics in second and third year provide the basis for specialization in a number of areas through more advanced elective courses in signal processing, digital and wireless communication, control systems, electric machines, robotics, power electronics, microwave and optical communication systems, and integrated circuit engineering. The Electrical Engineering plan also incorporates core and elective courses in digital logic, computer systems, and software for additional breadth.

The Electrical Engineering plan is "streamed". Through choice of elective courses in third and fourth year, students can either focus their studies in one or more areas of specialization ("streams"), or pursue a broader coverage of the subject field. Streams are detailed on the Departmental web pages.

First year courses in Mathematics (APSC 171, APSC 172, APSC 174), Physics (APSC 112), Engineering Practice (APSC 100) and Computing (APSC 142) form the basis for further study in Electrical Engineering. Good performance in these courses is advisable for students planning to enter this program.

Electrical Engineering, B.A.Sc. (Class of 2022)

Elective courses in years three and four are to be chosen from Electives Lists A and B, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 courses from Electives List A.
3. Have at least 5 four-hundred level elective courses.
4. Counting required core courses and elective courses in all four years, result in a total of no fewer than 157.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2019-2020

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 224 Continuous-Time Signals and Systems W | 3.75
- ELEC 252 Electronics I W | 4.25
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5

- MTHE 228 Complex Analysis W | 3.5
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- Complementary Studies, List A F | 3

Minimum Total Credits: 44.5

Third Year CORE 2020-2021

- ELEC 324 Discrete-Time Signals and Systems F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 353 Electronics II F | 4.25
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 372 Numerical Methods and Optimization W | 3.5
- ELEC 381 Applications of Electromagnetics W | 3.75
- ELEC 390 Principles of Design and Development W | K3.5
- ENPH 336 Solid State Devices W | 3.25
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- Technical Electives (choose 2) F/W | 6
- Complementary Studies F/W | 3

Minimum Total Credits: 41.75

Fourth Year CORE 2021-2022

- ELEC 490 Electrical Engineering Project FW | K7 *
- Complementary Studies F/W | 3
- Technical Electives F/W | 18.35

Minimum Total Credits: 28.35

* with Departmental and instructor support, students may request to substitute APSC 480 Multi-disciplinary Industry for ELEC 498 Computer Engineering Project.

Electives

Electrical Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the ECE Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Electrical Engineering Plan, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 (1 credit of communications units are also included in course ELEC 490).

Electrical Engineering, B.A.Sc. (Class of 2023)

Elective courses in years three and four are to be chosen from Electives Lists A and B, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 courses from Electives List A.
3. Have at least 5 four-hundred level elective courses.
4. Counting required core courses and elective courses in all four years, result in a total of no fewer than 157.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2020-2021

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 224 Continuous-Time Signals and Systems W | 3.75
- ELEC 252 Electronics I W | 4.25
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 228 Complex Analysis W | 3.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
  or
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- Complementary Studies, List A F/W/S | 3

Minimum Total Credits: 44.5

Third Year CORE 2021-2022

- ELEC 324 Discrete-Time Signals and Systems F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 353 Electronics II F | 4.25
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 372 Numerical Methods and Optimization W | 3.5
- ELEC 381 Applications of Electromagnetics W | 3.75
- ELEC 390 Principles of Design and Development W | K3.5
- ENPH 336 Solid State Devices W | 3.25
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- Technical Electives (choose 1) F/W | 3
- Complementary Studies F/W/S | 3

Minimum Total Credits: 38.75

Fourth Year CORE 2022-2023

- ELEC 490 Electrical Engineering Project FW | K7 *
- Technical Electives F/W | 21.35
- Complementary Studies F/W/S | 3

Total Credits: 31.35

* with Departmental and instructor support, students may request to substitute APSC 480 for ELEC 490

Electives

Electrical Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the ECE Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Electrical Engineering Plan, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 (1 credit of communications units are also included in course ELEC 490).

Electrical Engineering, B.A.Sc. (Class of 2024)

Elective courses in years three and four are to be chosen from Electives Lists A and B, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1. Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2. Have at least 5 courses from Electives List A.
3. Have at least 5 four-hundred level elective courses.
4. Counting required core courses and elective courses in all four years, result in a total of no fewer than 157.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2021-2022

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 224 Continuous-Time Signals and Systems W | 3.75
- ELEC 252 Electronics I W | 4.25
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 228 Complex Analysis W | 3.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
  or
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- Complementary Studies F/W/S | 3

Minimum Total Credits: 44.5

Third Year CORE 2022-2023

- ELEC 324 Discrete-Time Signals and Systems F | 4
- ELEC 326 Probability and Random Processes F | 3.5

- ELEC 353 Electronics II F | 4.25
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 372 Numerical Methods and Optimization W | 3.5
- ELEC 381 Applications of Electromagnetics W | 3.75
- ELEC 390 Principles of Design and Development W | K3.5
- ENPH 336 Solid State Devices W | 3.25
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- Technical Electives (choose 1) F/W | 3
- Complementary Studies F/W/S | 3

Minimum Total Credits: 38.75

Fourth Year CORE 2023-2024

- ELEC 490 Electrical Engineering Project FW | K7 *
- Technical Electives F/W | 21.35
- Complementary Studies F/W | 3

Total Credits: 31.35

* with Departmental and instructor support, students may request to substitute APSC 480 for ELEC 490

Electives

Electrical Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the ECE Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Electrical Engineering Plan, the Engineering

Economics course is APSC 221, and the Communications course is APSC 293 (1 credit of communications units are also included in course ELEC 490).

Electrical Engineering, ECEi Stream, B.A.Sc. (Class of 2022)

Elective courses in years three and four are to be chosen from Electives Lists A and B, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1) Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2) Have at least 5 courses from Electives List A.
3) Have at least 5 four-hundred level elective courses.
4) Counting required core courses and elective courses in all four years, result in a total of no fewer than 160.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2019-2020

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 224 Continuous-Time Signals and Systems W | 3.75
- ELEC 252 Electronics I W | 4.25
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 228 Complex Analysis W | 3.5
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- COMM 201 Introduction to Business for Entrepreneurs F | 3

Minimum Total Credits: 44.5

Third Year CORE 2020-2021

- ELEC 324 Discrete-Time Signals and Systems F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 353 Electronics II F | 4.25
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 372 Numerical Methods and Optimization W | 3.5
- ELEC 381 Applications of Electromagnetics W | 3.75
- ELEC 390 Principles of Design and Development W | K3.5
- COMM 301 Funding New Ventures S |3

- ENPH 336 Solid State Devices W | 3.25
- COMM 302 Launching New Ventures W |3
- Technical Electives (choose 2) F/W | 6
- Complementary Studies List A F/W | 3

Minimum Total Credits: 44.75

Fourth Year CORE 2021-2022

- ELEC 490 Electrical Engineering Project FW | K7 *
- COMM 405 New Business Development F| 3
- Technical Electives F/W | 18.35

Minimum Total Credits: 28.35

* with Departmental and instructor support, students may request to substitute APSC 480 for ELEC 490

Electives

Electrical Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

ECEi students are required to take a total of four Complementary Studies courses over 2nd, 3rd and 4th year: one elective Complementary Studies course from List A (Humanities and Social Sciences) and the required three courses COMM 301, COMM 302, and COMM 405.

Electrical Engineering, ECEi Stream, B.A.Sc. (Class of 2023)

Elective courses in years three and four are to be chosen from Electives Lists A and B, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1) Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2) Have at least 5 courses from Electives List A.
3) Have at least 5 four-hundred level elective courses.
4) Counting required core courses and elective courses in all four years, result in a total of no fewer than 160.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2020-2021

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 224 Continuous-Time Signals and Systems W | 3.75
- ELEC 252 Electronics I W | 4.25
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 228 Complex Analysis W | 3.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
  or
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- COMM 201 Introduction to Business for Entrepreneurs F | 3

Minimum Total Credits: 44.5

Third Year CORE 2021-2022

- ELEC 324 Discrete-Time Signals and Systems F | 4
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 353 Electronics II F | 4.25
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 372 Numerical Methods and Optimization W | 3.5
- ELEC 381 Applications of Electromagnetics W | 3.75
- ELEC 390 Principles of Design and Development W | K3.5
- ENPH 336 Solid State Devices W | 3.25
- COMM 301 Funding New Ventures S | 3
- COMM 302 Launching New Ventures W | 3
- Technical Electives (choose 1) F/W | 3
- Complementary Studies List A F/W/S | 3

Minimum Total Credits: 41.75

Fourth Year CORE 2022-2023

- ELEC 490 Electrical Engineering Project FW | K7 *
- COMM 405 New Business Development F | 3
- Technical Electives F/W | 21.35

Minimum Total Credits: 31.35

* with Departmental and instructor support, students may request to substitute APSC 480 for ELEC 490

Electives

Electrical Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the ECE Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

ECEi students are required to take a total of four Complementary Studies courses over 2nd, 3rd and 4th year: one elective Complementary Studies course from List A (Humanities and Social Sciences) and the required three courses COMM 301, COMM 302, and COMM 405.

Electrical Engineering, ECEi Stream, B.A.Sc. (Class of 2024)

Elective courses in years three and four are to be chosen from Electives Lists A and B, and by consulting suggested Streams and prerequisite paths. Your complete degree program must:

1) Satisfy the minimum Accreditation Units (AU) set by ECE in each CEAB category.
2) Have at least 5 courses from Electives List A.
3) Have at least 5 four-hundred level elective courses.
4) Counting required core courses and elective courses in all four years, result in a total of no fewer than 160.5 credits for the complete program.

Available combinations of elective courses are subject to timetabling constraints.

Second Year CORE 2021-2022

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ELEC 224 Continuous-Time Signals and Systems W | 3.75
- ELEC 252 Electronics I W | 4.25
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 299 Mechatronics Project W | K1.5
- MTHE 228 Complex Analysis W | 3.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
  or
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5
- COMM 201 Introduction to Business for Entrepreneurs F | 3

Minimum Total Credits: 44.5

Third Year CORE 2022-2023

- ELEC 324 Discrete-Time Signals and Systems F | 4
- ELEC 326 Probability and Random Processes F | 3.5

- ELEC 353 Electronics II F | 4.25
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 372 Numerical Methods and Optimization W | 3.5
- ELEC 381 Applications of Electromagnetics W | 3.75
- ELEC 390 Principles of Design and Development W | K3.5
- ENPH 336 Solid State Devices W | 3.25
- COMM 301 Funding New Ventures F | 3
- COMM 302 Launching New Ventures W | 3
- Technical Electives (choose 1) F/W | 3
- Complementary Studies List A F/W/S | 3

Minimum Total Credits: 41.75

Fourth Year CORE 2023-2024

- ELEC 490 Electrical Engineering Project FW | K7 *
- COMM 405 New Business Development F | 3
- Technical Electives F/W | 21.35

Minimum Total Credits: 31.35

* with Departmental and instructor support, students may request to substitute APSC 480 for ELEC 490

Electives

Electrical Engineering: Electives

Course Prerequisites

Normally, registration in a course offered by the ECE Department is allowed provided a mark of at least D- has been achieved in each of the prerequisites for the course. Students having one course prerequisite (numbered 200 or higher) with a mark of FR may still be able to register in a course offered by the Department provided their Engineering Cumulative GPA is at least 2.0 at the end of the previous session. Prerequisites are listed under the calendar description for each course.

Complementary Studies

ECEi students are required to take a total of four Complementary Studies courses over 2nd, 3rd and 4th year: one elective Complementary Studies course from List A (Humanities and Social Sciences) and the required three courses COMM 301, COMM 302, and COMM 405.

Electrical Engineering: Electives

Electives List A

- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 279 Introduction to Object Oriented Programming W | 4
- ELEC 333 Electric Machines W | 4.25
- ELEC 344 Sensors and Actuators F | 3.75
- ELEC 373 Computer Networks W | 3.5
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- ELEC 409 Bioinformatic Analytics F | 3
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 422 NOT OFFERED 2021-2022 Digital Signal Processing: Random Models and Applications F | 3.5
- ELEC 425 Machine Learning and Deep Learning F | 3.5
- ELEC 431 Power Electronics F | 3.25
- ELEC 433 Energy and Power Systems W | 3.5
- ELEC 436 NOT OFFERED 2021-22 Electric Machines and Control W | 3
- ELEC 443 Linear Control Systems F | 4.25
- ELEC 444 NOT OFFERED 2021-2022 Modeling and Computer Control of Mechatronic Systems W | 3.25
- ELEC 448 Introduction to Robotics: Mechanics and Control F | 3.5
  or
- MECH 456 Introduction to Robotics F | 3.5
- ELEC 451 Digital Integrated Circuit Engineering F | 3.25
- ELEC 454 NOT OFFERED 2021-2022 Analog Electronics W | 3.25
- ELEC 457 Integrated Circuits and System Applications W | 3.25
- ELEC 461 NOT OFFERED 2021-2022 Digital Communications F | 3.5
- ELEC 464 Wireless Communications F | 3
- ELEC 470 Computer System Architecture W | 3.5
- ELEC 472 Artificial Intelligence W | 3.5
- ELEC 473 Cryptography and Network Security F | 3
- ELEC 474 Machine Vision F | 3.5
- ELEC 481 NOT OFFERED 2021-2022 Applications of Photonics W | 3
- ELEC 483 Microwave and RF Circuits and Systems W | 4.25
- ELEC 486 Fiber Optic Communications F | 3.75
- ELEC 497 Research Project FW/S | K3.5

Electives List B

- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- APSC 303 Professional Internship | 3.5

- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7
- APSC 401 Interdisciplinary Projects W | K4.5
- CHEE 340 Biomedical Engineering W | 3.5
- ENPH 460 Laser Optics W | 3.5
- CMPE 3XX Any Third Year Computing Science Course | 3
- CMPE 4XX Any Fourth Year Computing Science Course | 3
- MTHE 337 Introduction to Operations Research Models W | 3
- MTHE 367 NOT OFFERED 2021-2022 - Engineering Data Analysis W | 3.5
- MTHE 430 Modern Control Theory F | 4
- MTHE 455 Stochastic Processes and Applications F | 3.5
- MTHE 472 Control of Stochastic Systems W | 3
- MTHE 474 Information Theory F | 3
- MTHE 477 Data Compression and Source Coding W | 3
- MTHE 478 NOT OFFERED 2021-2022 - Topics in Communication Theory F/W | 3
- MECH 228 Kinematics and Dynamics W | K3.5
- MECH 328 Dynamics and Vibration F | 3.5
- MECH 393 Biomechanical Product Development W | 3.5
- MECH 423 Introduction to Microsystems W | 3.5
- MECH 455 Computer Integrated Manufacturing F | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 494 Kinematics of Human Motion W | 3.5
- MINE 472 Not Offered 2021-2022 Mining Systems, Automation, and Robotics O/L | K3.5

Engineering Chemistry

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The Engineering Chemistry program is offered by the Department of Chemical Engineering with the close cooperation of the Department of Chemistry. The academic program is accredited by the Canadian Engineering Accreditation Board as an engineering discipline and the Canadian Society for Chemistry as a chemistry program. The curriculum integrates a core of chemistry with a body of engineering in a manner that allows chemical knowledge to be put into practice. Beginning with a concentration on basic engineering principles, science, and mathematics, students can gain specialization in areas such as process chemistry, materials science, biosciences and pharmaceuticals, through selection of electives and thesis project. They also work on group design projects throughout the design spine. In their fourth year students work on a year-long research thesis project, under the supervision of academic staff. All students have access to a computing facility, equipped with software programs and simulators.

Ancillary Fees

Chemical Engineering and Engineering Chemistry students may be required to pay ancillary fees for course related learning materials, safety equipment and field trips.

Engineering Chemistry, B.A.Sc. (Class of 2022)

Second Year CORE 2019-2020

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 270 ChemEtronics F | K3
- ENCH 211 Main Group Chemistry F | 4.75
- ENCH 212 Principles of Chemical Reactivity F | 4
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 222 Methods of Structure Determination W | 3.75
- ENCH 245 Applied Organic Chemistry I W | 4.75

Minimum Total Credits: 46.25

Third Year CORE 2020-2021

- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- ENCH 213 Introduction to Chemical Analysis F | 4.75
- ENCH 312 Transition Metal Chemistry F | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CHEE 324 NOT OFFERED 2021-2022 Organic Process Development W | 3.5
- CHEE 331 Design of Unit Operations W | K4.5
- CHEE 361 Engineering Communications, Ethics & Professionalism W | K1
- CHEE 363 Electrochemical Engineering* W | 3.5
- ENCH 399 Experimental Chemistry II W | 3.5

- ELECTIVES (minimum 3 credits) F/W | 3

Minimum Total Credits: 44.25

Fourth Year CORE 2021-2022

- CHEE 460 Applied Surface and Colloid Science F | 3.5
- ENCH 313 Quantum Mechanics F | 3.5
- CHEE 471 Chemical Process Design FW | 7
- ENCH 417 Research Project FW | 9
- CHEE 415 Engineering Chemistry Laboratory W | 4
- CHEE 463 Electrochemical Energy Systems W | 3.5
  Electives (minimum 15 credits) F/W | 15

Minimum Total Credits: 45.5

Technical Electives:

Students in the ENCH program are required to take two (2) courses from the approved Group A list (any combination from Materials, Environment, Biosciences, and General lists), and one (1) course from the approved Group B list.

Engineering Chemistry: Technical Electives

Engineering Economics:

To meet the engineering economics requirement, students take APSC 221.

Communications:

To meet the communications requirement, students take APSC 293 and CHEE 361 (these are CORE courses).

Complementary Studies:

Students choose a total of 9 credits from the approved Lists A or B, of which 3 credits must be taken from List A.

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Chemistry, B.A.Sc. (Class of 2023)

Second Year CORE 2020-2021

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 270 ChemEtronics F | K3
- ENCH 211 Main Group Chemistry F | 4.75
- ENCH 212 Principles of Chemical Reactivity F | 4
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 222 Methods of Structure Determination W | 3.75
- ENCH 245 Applied Organic Chemistry I W | 4.75

Minimum Total Credits: 46.25

Third Year CORE 2021-2022

- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- ENCH 213 Introduction to Chemical Analysis F | 4.75
- ENCH 312 Transition Metal Chemistry F | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CHEE 331 Design of Unit Operations W | K4.5
- CHEE 361 Engineering Communications, Ethics & Professionalism W | K1
- CHEE 363 Electrochemical Engineering* W | 3.5
- ENCH 399 Experimental Chemistry II W | 3.5
- Electives (minimum 6 credits) F/W | 6

Minimum Credits: 43.75

Fourth Year CORE 2022-2023

- CHEE 460 Applied Surface and Colloid Science F | 3.5
- ENCH 313 Quantum Mechanics F | 3.5

- CHEE 324 NOT OFFERED 2021-2022 Organic Process Development W | 3.5
- CHEE 471 Chemical Process Design FW | 7
- ENCH 417 Research Project FW | 9
- CHEE 415 Engineering Chemistry Laboratory W | 4
- CHEE 463 Electrochemical Energy Systems W | 3.5
- Electives (minimum 12 credits) F/W | 12

Minimum Total Credits: 46

Technical Electives:

Students in the ENCH program are required to take two (2) technical elective courses from the approved Group A list (any combination from Materials, Environment, Biosciences, and General lists), and one (1) technical elective course from the approved Group B list.

Engineering Chemistry: Technical Electives

Complementary Studies:

Students choose a total of 9 credits from the approved Lists A or B, of which 3 credits must be taken from List A.

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics:

To meet the engineering economics requirement students take APSC 221 (this is a CORE course).

Communications:

To meet the communications requirement, students take APSC 293 and CHEE 361 (these are CORE courses).

Engineering Chemistry, B.A.Sc. (Class of 2024)

Second Year CORE 2021-2022

- CHEE 209 Analysis of Process Data F | 3.5
- CHEE 221 Chemical Processes and Systems F | 3.5
- CHEE 270 ChemEtronics F | K3

- ENCH 211 Main Group Chemistry F | 4.75
- ENCH 212 Principles of Chemical Reactivity F | 4
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CHEE 222 Process Dynamics and Numerical Methods W | 3.5
- CHEE 223 Fluid Mechanics W | 3.5
- ENCH 222 Methods of Structure Determination W | 3.75
- ENCH 245 Applied Organic Chemistry I W | 4.75

Minimum Total Credits: 46.25

Third Year CORE 2022-2023

- CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5
- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 380 Biochemical Engineering F | 3.5
- ENCH 213 Introduction to Chemical Analysis F | 4.75
- ENCH 312 Transition Metal Chemistry F | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- CHEE 324 NOT OFFERED 2021-2022 Organic Process Development W | 3.5
- CHEE 331 Design of Unit Operations W | K4.5
- CHEE 361 Engineering Communications, Ethics & Professionalism W | K1
- CHEE 363 Electrochemical Engineering* W | 3.5
- ENCH 399 Experimental Chemistry II W | 3.5
  Electives (minimum 3 credits) F/W | 3

Minimum Credits: 44.25

Fourth Year CORE 2023-2024

- CHEE 460 Applied Surface and Colloid Science F | 3.5
- ENCH 313 Quantum Mechanics F | 3.5
- CHEE 471 Chemical Process Design FW | 7
- ENCH 417 Research Project FW | 9
- CHEE 415 Engineering Chemistry Laboratory W | 4
- CHEE 463 Electrochemical Energy Systems W | 3.5
  Electives (minimum 15 credits) F/W | 15

Minimum Total Credits: 45.5

Technical Electives:

Students in the ENCH program are required to take two (2) courses from the approved Group A list (any combination from Materials, Environment, Biosciences, and General lists), and one (1) course from the approved Group B list.

Engineering Chemistry: Technical Electives

Complementary Studies:

Students choose a total of 9 credits from the approved Lists A or B, of which 3 credits must be taken from List A.

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans.

Engineering Economics:

To meet the engineering economics requirement, students take APSC 221.

Communications:

To meet the communications requirement, students take APSC 293 and CHEE 361 (these are CORE courses).

Engineering Chemistry: Technical Electives

TECHNICAL ELECTIVES

PLEASE NOTE: Some of these elective courses may not be available to students due to pre-requisite course requirements. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor.

PLEASE NOTE: Course availability and the term in which a course is held can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to SOLUS to find out if the TECH course is offered this upcoming year.

GROUP A TECHNICAL ELECTIVES

Biomedical

- CHEE 340 Biomedical Engineering W | 3.5
- CHEE 440 Pharmaceutical Technology W | 3.5
- MECH 393 Biomechanical Product Development W | 3.5
- MECH 492 Biological Fluid Dynamics F | 3.5

Energy, Energy Resources, and Petroleum Engineering

- CHEE 414 Foundations of the Oil and Gas Industry W | K3.5
- MECH 435 Internal Combustion Engines F | 3.5
- MECH 437 Fuel Cell Technology F | 3.5
- MECH 439 Turbomachinery W | 3.5

Environmental

- CHEE 342 Environmental Biotechnology F | 3.5
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- CHEE 484 NOT OFFERED 2021-2022 Bioremediation W | 3.5
- CIVL 371 Groundwater Engineering F | 3.75
- CIVL 372 Water and Wastewater Engineering W | 4
- CIVL 451 Lake, Reservoir and Coastal Engineering F | 3.75
- CIVL 471 Subsurface Contamination F | 4

Materials Processing

- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 490 Polymer Formulations and Processing Technology W | 3.5

Minerals Processing

- MINE 331 Methods of Mineral Separation F | 4.5
- MINE 335 Mineral Processing F | 3
- MINE 451 Chemical Extraction of Metals F | 4
- MNTC 306 Mineral Processing Unit Operations O/L | 3
- MNTC 311 Ore Body Modelling and Resource Estimation O/L | 4.5
- MNTC 415 Metal Extraction Processes O/L | 4

General

- APSC 303 Professional Internship | 3.5
- APSC 381 Advanced Design and Skills for Innovation W | K3.5
- APSC 401 Interdisciplinary Projects W | K4.5
- CHEE 319 Process Dynamics and Control W | 3.5

- CHEE 410 Engineering Innovation and Entrepreneurship W | K4
- CHEE 412 Transport Phenomena W | 3.5
- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 434 Process Control II W | 3.5
- MECH 430 NOT OFFERED 2021-2022 - Thermal Systems Design W | 4
- MECH 480 Airplane Aerodynamics and Performance W | 3.5

  NOTE: APSC 303 will count as a Group A Technical Elective upon successful completion of internship.

GROUP B TECHNICAL ELECTIVES

All CHEM/ENCH courses numbered from 311 to 489, excluding those courses already required in the core of the program, can be considered as a Group B TECH course.

- ENCH 311 Mechanistic Organic Chemistry F | 3.5
- ENCH 321 Instrumental Chemical Analysis W | 3
- ENCH 322 The Chemical Bond: Computation and Spectroscopy W | 3.5
- ENCH 323 Biological Chemistry W | 3
- ENCH 326 Environmental and Green Chemistry W | 3
- ENCH 411 Advanced Analytical Chemistry F | 3
- ENCH 412 NOT OFFERED 2021-2022 - Statistical Mechanics W | 3
- ENCH 413 Computational Chemistry F | 3
- ENCH 414 Catalysis F | 3
- ENCH 421 Advanced Methods in Physical Chemistry W | 3
- ENCH 422 Synthetic Organic Chemistry W | 3.5
- ENCH 423 Topics in Inorganic and Organometallic Chemistry W | 3
- ENCH 424 NOT OFFERED 2021-2022 Polymer Chemistry W | 3
- ENCH 425 Self-Assembly and Materials W | 3

Engineering Physics

Department Head Rob Knobel
Chair of Undergraduate Studies Jun Gao
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Core courses in the Engineering Physics plan provide the student with fundamental physical principles and theoretical tools for professional practice as well as a firm foundation in modern experimental techniques. To relate these abilities to the attitudes and knowledge of other engineering disciplines, the plan has four sub-plans: electrical, materials, mechanical, and computing. These sub-plans provide a sequence of courses in other engineering departments and thus provide career or graduate studies opportunities in both engineering and applied physics.

NOTE: Students will not be registered in any core second year engineering physics courses until they have passed all the required first year mathematics and physics courses. It is strongly recommended that students have a grade of C- or better in the first year mathematics and physics courses.

Fourth year elective courses must be chosen such that at the end of the academic plan each student meets or exceeds the Canadian Engineering Accreditation Board (CEAB) program requirements. A spreadsheet will be provided by the Undergraduate Chair to aid fourth year students with their course selection.

Options available:

- Electrical Option
- Materials Option
- Mechanical Option
- Computing Option

Engineering Physics, B.A.Sc. (Class of 2022)

Second Year CORE 2019-2020

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ENPH 211 Applied Physics W | 3.5
- ENPH 213 Computational Engineering Physics W | 4
- ENPH 225 Mechanics W | 3.5
- ENPH 239 Electricity and Magnetism W | 3.5
- ENPH 242 Relativity and Quanta F | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- ENPH 253 Engineering Physics Laboratory W | K3.5
- MTHE 227 Vector Analysis F | 3
- MTHE 237 Differential Equations for Engineering Science F | 3.25

Electrical Sub-Plan (P1)

- ELEC 252 Electronics I W | 4.25
- ELEC 278 Fundamentals of Information Structures F | 4

Minimum Units: 46.5

Materials Sub-Plan (P3)

- MECH 241 Fluid Mechanics I W/S/OL | 3.5
- MECH 270 Materials Science and Engineering F | 3.5

Minimum Units: 45.25

Mechanical Sub-Plan (P4)

- MECH 230 Applied Thermodynamics I F | 3.5
- MECH 241 Fluid Mechanics I W/S/OL | 3.5

Minimum Units: 45.25

Computing Sub-Plan (P6)

- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 278 Fundamentals of Information Structures F | 4

Minimum Units: 46.25

Third Year CORE 2020-2021

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ENPH 344 Introduction to Quantum Mechanics F | 3.5
- ENPH 316 Mathematical Methods in Physics I F | 3.5
- ENPH 345 Quantum Physics of Atoms, Nuclei and Particles W | 3.5
- ENPH 354 Engineering Physics Design Project W | 3.5

Notes:

*MTHE 338 may be replaced by taking ENPH 316 and ENPH 317. However, in 2020-2021, MTHE 338 will not be offered. ENPH 317 can be taken in 3rd or 4th year and is a Physics List A elective.

** Students are free to take Complementary Studies courses at any time in their program that suits their interests, workloads, and schedules. Read explanatory notes on Complementary Studies at the end of this section.

APSC 303 may be taken as a List B technical elective for students that have successfully completed the internship program (QUIP).

APSC 381 may be taken as a technical elective for students particularly interested in engineering design.

ENPH 491 and ENPH 495 are fourth year Physics List A electives offered every second year which students in their third year can consider taking.

Note: In the third year of the Engineering Physics program students may apply to the Accelerated Masters program. In this program, students work closely with a supervisor in the summer after the third year of school doing research that leads towards a Masters degree in Physics or Engineering Physics. To accelerate students' progress towards a Masters degree, students take two graduate courses in their fourth year. These courses replace the Engineering Elective and a List "A" or List "B" course in the undergraduate program. Students enroll in ENPH 555 for their undergraduate thesis instead of ENPH 455. Students are admitted based on a minimum GPA of 3.7 and acceptance by a supervisor. Students are expected to finish their full Masters degree within 16 months after the undergraduate program, saving a year of time. For details see http://queensu.ca/physics/undergrad-studies/accelerated-msc-masc

Electrical Sub-Plan (P1)

- ELEC 353 Electronics II F | 4.25
- ENPH 336 Solid State Devices W | 3.25
- ENPH 372 Thermodynamics W | 3.5
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4

Minimum Units: 41.5

Materials Sub-Plan (P3)

- ENPH 334 Electronics for Applied Scientists F | 5
- ENPH 372 Thermodynamics W | 3.5
- MECH 370 Principles of Materials Processing F | 3.5
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Minimum Units: 42

Mechanical Sub-Plan (P4)

- ENPH 334 Electronics for Applied Scientists F | 5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5

Minimum Units: 41.5

Computing Sub-Plan (P6)

- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ENPH 334 Electronics for Applied Scientists F | 5
- ENPH 372 Thermodynamics W | 3.5

Minimum Units: 43

Fourth Year CORE 2021-2022

- ENPH 431 Electromagnetic Theory F | 3.5
- ENPH 453 Advanced Physics Laboratory W | 3.5
- ENPH 454 Advanced Engineering Physics Design Project F | 4.5
- ENPH 455 Engineering Physics Thesis FW | 4
  Engineering Elective (any 200-, 300- or 400-level Engineering and Applied Science course) F/W | 3

Notes:

* Students may take ENPH 555 as an alternative to ENPH 455. See the Notes regarding the Accelerated Masters program after the 3rd year program listing.

** Students may instead take APSC 480 Multi-disciplinary Industry Engineering Design Project (9 credits FW) as a substitute for ENPH 454 and one list "B" course. Note that APSC 480 has a prerequisite of APSC 381 or permission of the instructor.

One from Physics List A:

Physics List A:

- ENPH 317 Mathematical Methods in Physics II W | 3.5
- ENPH 321 Advanced Mechanics F | 3.5
- ENPH 414 Introduction to General Relativity W | 3
- ENPH 460 Laser Optics W | 3.5
- ENPH 472 Statistical Mechanics F | 3.5
- ENPH 479 High Performance Computing in Engineering Physics W | 3
- ENPH 480 Solid State Physics F | 3.5
- ENPH 483 Nanoscience and Nanotechnology W | 3.5

- ENPH 490 Nuclear Physics F | 3.5
- ENPH 491 NOT OFFERED 2021-2022 Physics of Nuclear Reactors F | 3.5
- ENPH 495 Introduction to Medical Physics W | 3

Electrical Sub-Plan (P1)

Two courses from Electrical List B, and one course from Electrical List B or Physics List A, at least one of which must be numbered above 400*:

Electrical List B:

- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 333 Electric Machines W | 4.25
- ELEC 344 Sensors and Actuators F | 3.75
- ELEC 373 Computer Networks W | 3.5
- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- ELEC 409 Bioinformatic Analytics F | 3
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 422 NOT OFFERED 2021-2022 Digital Signal Processing: Random Models and Applications F | 3.5
- ELEC 431 Power Electronics F | 3.25
- ELEC 443 Linear Control Systems F | 4.25
- ELEC 448 Introduction to Robotics: Mechanics and Control F | 3.5
- ELEC 451 Digital Integrated Circuit Engineering F | 3.25
- ELEC 454 NOT OFFERED 2021-2022 Analog Electronics W | 3.25
- ELEC 457 Integrated Circuits and System Applications W | 3.25
- ELEC 461 NOT OFFERED 2021-2022 Digital Communications F | 3.5
- ELEC 464 Wireless Communications F | 3
- ELEC 483 Microwave and RF Circuits and Systems W | 4.25
- ELEC 486 Fiber Optic Communications F | 3.75
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Minimum Units: 36.5

Materials Sub-Plan (P3)

- ENPH 480 Solid State Physics F | 3.5

Materials List B:

Two courses from Materials List B*:

- MECH 437 Fuel Cell Technology F | 3.5
- MECH 423 Introduction to Microsystems W | 3.5
- MECH 470 Deformation Processing W | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 479 Nano-Structured Materials F | 3.5
- MECH 483 Nuclear Materials F | 3.5
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a list B course above with a list B course from one of the other options within Engineering Physics.

Minimum Units: 38

Mechanical Sub-Plan (P4)

Three courses: two from Mechanical List B, and one from Physics List A or Mechanical List B*:

Mechanical List B:

- CHEE 340 Biomedical Engineering W | 3.5
- MECH 420 NOT OFFERED 2021-2022 - Vibrations W | 3.5
- MECH 423 Introduction to Microsystems W | 3.5
- MECH 424 NOT OFFERED 2021-2022 - Sustainable Product Design F | 3.5
- MECH 430 NOT OFFERED 2021-2022 - Thermal Systems Design W | 4
- MECH 435 Internal Combustion Engines F | 3.5
- MECH 437 Fuel Cell Technology F | 3.5
- MECH 439 Turbomachinery W | 3.5
- MECH 441 NOT OFFERED 2021-2022 - Fluid Mechanics III W | 3.5
- MECH 444 NOT OFFERED 2021-2022 - Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow W | 3.5
- MECH 452 Mechatronics Engineering F | 5
- MECH 456 Introduction to Robotics F | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 481 NOT OFFERED 2021-2022 - Wind Energy F | 3.5
- MECH 482 Noise Control W | 3.5
- MECH 492 Biological Fluid Dynamics F | 3.5

- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Minimum Units: 37.5

Computing Sub-Plan (P6)

Three courses: two from Computing List B and one from Physics List A or Computing List B. At least one of the Computing List B courses must be numbered above 400*:

Computing List B:

- CHEE 340 Biomedical Engineering W | 3.5
- CMPE 330 Computer-Integrated Surgery F | 3
- CMPE 365 Algorithms I F | 4
- CMPE 452 Neural Networks and Genetic Algorithms F | 3
- CMPE 454 Computer Graphics W | 3
- CMPE 457 Image Processing and Computer Vision F | 3
- CMPE 458 Programming Language Processors W | 4
- CMPE 472 Medical Informatics W | 3
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- ELEC 409 Bioinformatic Analytics F | 3

Note:

[1]With permission of the instructor.

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other sub-plans within Engineering Physics.

Minimum Units: 39.5

Complementary Studies:

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Engineering Physics Plan, the Engineering

Economics course is APSC 221 , and the Communications requirements are met through courses in the core plan.

Engineering Physics, B.A.Sc. (Class of 2023)

Second Year CORE - 2020-2021

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- ELEC 221 Electric Circuits F | 4.25
- ENPH 211 Applied Physics W | 3.5
- ENPH 213 Computational Engineering Physics W | 4
- ENPH 239 Electricity and Magnetism W | 3.5
- ENPH 242 Relativity and Quanta F | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- ENPH 253 Engineering Physics Laboratory W | K3.5
- MTHE 227 Vector Analysis F | 3
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5

Electrical Sub-Plan (P1)

- ELEC 252 Electronics I W | 4.25
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 224 Continuous-Time Signals and Systems W | 3.75

Minimum Units: 46.75

Materials Sub-Plan (P3)

- MECH 241 Fluid Mechanics I W/S/OL | 3.5
- MECH 270 Materials Science and Engineering F | 3.5
- ENPH 225 Mechanics W | 3.5

Minimum Units: 45.25

Mechanical Sub-Plan (P4)

- MECH 230 Applied Thermodynamics I F | 3.5
- MECH 241 Fluid Mechanics I W/S/OL | 3.5
- ENPH 225 Mechanics W | 3.5

Minimum Units: 45.25

Computing Sub-Plan (P6)

- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ENPH 225 Mechanics W | 3.5

Minimum Units: 46.25

Third Year CORE - 2021-2022

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ENPH 344 Introduction to Quantum Mechanics F | 3.5
- ENPH 345 Quantum Physics of Atoms, Nuclei and Particles W | 3.5
- ENPH 353 Engineering Physics Laboratory II F | 2.5
- ENPH 354 Engineering Physics Design Project W | 3.5
- ENPH 316 Mathematical Methods in Physics I F | 3.5

Notes:

* ENPH 317 can be taken in 3rd or 4th year and is a Physics List A elective.

** Students are free to take Complementary Studies courses at any time in their program that suits their interests, workloads, and schedules. Read explanatory notes on Complementary Studies at the end of this section.

APSC 303 may be taken as a List B technical elective for students that have successfully completed the internship program (QUIP).

APSC 381 may be taken as a technical elective for students particularly interested in engineering design.

Physics list A electives ENPH 491 and ENPH 495 typically are not offered every year, thus students may want to consider adding them to their third year program.

Note: In the third year of the Engineering Physics program students may apply to the Accelerated Masters program. In this program, students work closely with a supervisor in the summer after the third year of school doing research that leads towards a Masters degree in Physics or Engineering Physics. To accelerate students' progress towards a Masters degree, students take two graduate courses in their fourth year. These courses replace the Engineering Elective and a List "A" or List "B" course in the undergraduate program. Students enroll in ENPH 555 for their undergraduate thesis instead of ENPH 455. Students are admitted based on a minimum GPA of 3.7 and acceptance by a supervisor. Students are expected to finish their full Masters degree within 16 months after the undergraduate program, saving a year of time. For details see http://queensu.ca/physics/undergrad-studies/accelerated-msc-masc

Electrical Sub-Plan (P1)

- ELEC 353 Electronics II F | 4.25
- ENPH 336 Solid State Devices W | 3.25
- ENPH 372 Thermodynamics W | 3.5
- ELEC 324 Discrete-Time Signals and Systems F | 4
- ENPH 225 Mechanics W | 3.5

Minimum Units: 41.75

Materials Sub-Plan (P3)

- ENPH 334 Electronics for Applied Scientists F | 5
- ENPH 372 Thermodynamics W | 3.5
- MECH 370 Principles of Materials Processing F | 3.5
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Minimum Units: 39

Mechanical Sub-Plan (P4)

- ENPH 334 Electronics for Applied Scientists F | 5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5

Minimum Units: 38.5

Computing Sub-Plan (P6)

- CMPE 320 Fundamentals of Software Development F | 4
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ENPH 334 Electronics for Applied Scientists F | 5
- ENPH 372 Thermodynamics W | 3.5

Fourth Year CORE - 2022-2023

- ENPH 431 Electromagnetic Theory F | 3.5

- ENPH 453 Advanced Physics Laboratory W | 3.5
- ENPH 454 Advanced Engineering Physics Design Project F | 4.5
- ENPH 455 Engineering Physics Thesis FW | 4
- Engineering Elective (any 200-, 300- or 400-level Engineering and Applied Science course) F/W | 3

Note:

* Students may take ENPH 555 as an alternative to ENPH 455. See the Notes regarding the Accelerated Masters program after the 3rd year program listing.

** Students may instead take APSC 480, Multi-disciplinary Industry Engineering Design Project (9 credits FW) as a substitute for ENPH 454 and one list "B" course. Note that APSC 480 has a prerequisite of APSC 381 or permission of the instructor.

One from Physics List A:

Physics List A:

- ENPH 317 Mathematical Methods in Physics II W | 3.5
- ENPH 321 Advanced Mechanics F | 3.5
- ENPH 414 Introduction to General Relativity W | 3
- ENPH 460 Laser Optics W | 3.5
- ENPH 472 Statistical Mechanics F | 3.5
- ENPH 479 High Performance Computing in Engineering Physics W | 3
- ENPH 480 Solid State Physics F | 3.5
- ENPH 483 Nanoscience and Nanotechnology W | 3.5
- ENPH 490 Nuclear Physics F | 3.5
- ENPH 491 NOT OFFERED 2021-2022 Physics of Nuclear Reactors F | 3.5
- ENPH 495 Introduction to Medical Physics W | 3

Electrical Sub-Plan (P1)

Two courses from Electrical List B, and one course from Electrical List B or Physics List A, at least one of which must be numbered above 400*:

Electrical List B:

- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 333 Electric Machines W | 4.25

- ELEC 344 Sensors and Actuators F | 3.75
- ELEC 373 Computer Networks W | 3.5
- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- ELEC 409 Bioinformatic Analytics F | 3
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 422 NOT OFFERED 2021-2022 Digital Signal Processing: Random Models and Applications F | 3.5
- ELEC 431 Power Electronics F | 3.25
- ELEC 443 Linear Control Systems F | 4.25
- ELEC 448 Introduction to Robotics: Mechanics and Control F | 3.5
- ELEC 451 Digital Integrated Circuit Engineering F | 3.25
- ELEC 454 NOT OFFERED 2021-2022 Analog Electronics W | 3.25
- ELEC 457 Integrated Circuits and System Applications W | 3.25
- ELEC 461 NOT OFFERED 2021-2022 Digital Communications F | 3.5
- ELEC 464 Wireless Communications F | 3
- ELEC 483 Microwave and RF Circuits and Systems W | 4.25
- ELEC 486 Fiber Optic Communications F | 3.75
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Minimum Units: 36.5

Materials Sub-Plan (P3)

- ENPH 480 Solid State Physics F | 3.5

Materials List B:

Two courses from Materials List B*:

- MECH 423 Introduction to Microsystems W | 3.5
- MECH 437 Fuel Cell Technology F | 3.5
- MECH 470 Deformation Processing W | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 479 Nano-Structured Materials F | 3.5
- MECH 483 Nuclear Materials F | 3.5
- MECH 484 DELETED - Introduction to Ceramics F | 3.5
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a list B course above with a list B course from one of the other options within Engineering Physics.

Minimum Units: 38

Mechanical Sub-Plan (P4)

Three courses: two from Mechanical List B, and one from Physics List A or Mechanical List B*:

Mechanical List B:

- CHEE 340 Biomedical Engineering W | 3.5
- MECH 420 NOT OFFERED 2021-2022 - Vibrations W | 3.5
- MECH 423 Introduction to Microsystems W | 3.5
- MECH 424 NOT OFFERED 2021-2022 - Sustainable Product Design F | 3.5
- MECH 430 NOT OFFERED 2021-2022 - Thermal Systems Design W | 4
- MECH 435 Internal Combustion Engines F | 3.5
- MECH 437 Fuel Cell Technology F | 3.5
- MECH 439 Turbomachinery W | 3.5
- MECH 441 NOT OFFERED 2021-2022 - Fluid Mechanics III W | 3.5
- MECH 444 NOT OFFERED 2021-2022 - Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow W | 3.5
- MECH 452 Mechatronics Engineering F | 5
- MECH 456 Introduction to Robotics F | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 481 NOT OFFERED 2021-2022 - Wind Energy F | 3.5
- MECH 482 Noise Control W | 3.5
- MECH 492 Biological Fluid Dynamics F | 3.5
- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Minimum Units: 37.5

Computing Sub-Plan (P6)

Three courses: two from Computing List B and one from Physics List A or Computing List B. At least one of the Computing List B courses must be numbered above 400*:

Computing List B:

- CHEE 340 Biomedical Engineering W | 3.5
- CMPE 330 Computer-Integrated Surgery F | 3
- CMPE 365 Algorithms I F | 4
- CMPE 452 Neural Networks and Genetic Algorithms F | 3
- CMPE 454 Computer Graphics W | 3
- CMPE 457 Image Processing and Computer Vision F | 3
- CMPE 458 Programming Language Processors W | 4
- CMPE 472 Medical Informatics W | 3
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- ELEC 409 Bioinformatic Analytics F | 3

Note:

[1]With permission of the instructor.

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other sub-plans within Engineering Physics.

Minimum Units: 37.5

Complementary Studies:

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Engineering Physics Plan, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses in the core plan.

Engineering Physics, B.A.Sc. (Class of 2024)

Second Year CORE 2021-2022

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- MTHE 227 Vector Analysis F | 3
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- ENPH 242 Relativity and Quanta F | 3.5

- ELEC 221 Electric Circuits F | 4.25
- ENPH 211 Applied Physics W | 3.5
- ENPH 239 Electricity and Magnetism W | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- ENPH 253 Engineering Physics Laboratory W | K3.5
- ENPH 213 Computational Engineering Physics W | 4

Electrical Sub-Plan (P1)

- ELEC 224 Continuous-Time Signals and Systems W | 3.75
- ELEC 252 Electronics I W | 4.25
- ELEC 278 Fundamentals of Information Structures F | 4

Minimum Units: 46.5

Materials Sub-Plan (P3)

- ENPH 225 Mechanics W | 3.5
- MECH 270 Materials Science and Engineering F | 3.5
- MECH 241 Fluid Mechanics I W/S/OL | 3.5

Minimum Units: 45.25

Mechanical Sub-Plan (P4)

- ENPH 225 Mechanics W | 3.5
- MECH 230 Applied Thermodynamics I F | 3.5
- MECH 241 Fluid Mechanics I W/S/OL | 3.5

Minimum Units: 45.25

Computing Sub-Plan (P6)

- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ENPH 225 Mechanics W | 3.5

Minimum Units: 46.25

Third Year CORE 2022-2023

- ENPH 344 Introduction to Quantum Mechanics F | 3.5

- ENPH 354 Engineering Physics Design Project W | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ENPH 345 Quantum Physics of Atoms, Nuclei and Particles W | 3.5
- ENPH 353 Engineering Physics Laboratory II F | 2.5
- ENPH 316 Mathematical Methods in Physics I F | 3.5

Note:

* ENPH 317 can be taken in 3rd or 4th year and is a Physics List A elective.

** Students are free to take Complementary Studies courses at any time in their program that suits their interests, workloads, and schedules. Read explanatory notes on Complementary Studies at the end of this section.

APSC 303 may be taken as a List B technical elective for students that have successfully completed the internship program (QUIP).

APSC 381 may be taken as a technical elective for students particularly interested in engineering design.

Physics list A electives ENPH 491 and ENPH 495 typically are not offered every year, thus students may want to consider adding them to their third year program.

Note: In the third year of the Engineering Physics program students may apply to the Accelerated Masters program. In this program, students work closely with a supervisor in the summer after the third year of school doing research that leads towards a Masters degree in Physics or Engineering Physics. To accelerate students' progress towards a Masters degree, students take two graduate courses in their fourth year. These courses replace the Engineering Elective and a List "A" or List "B" course in the undergraduate program. Students enroll in ENPH 555 for their undergraduate thesis instead of ENPH 455. Students are admitted based on a minimum GPA of 3.7 and acceptance by a supervisor. Students are expected to finish their full Masters degree within 16 months after the undergraduate program, saving a year of time. For details see http://queensu.ca/physics/undergrad-studies/accelerated-msc-masc

Electrical Sub-Plan (P1)

- ELEC 353 Electronics II F | 4.25
- ELEC 324 Discrete-Time Signals and Systems F | 4
- ENPH 225 Mechanics W | 3.5
- ENPH 336 Solid State Devices W | 3.25
- ENPH 372 Thermodynamics W | 3.5

Minimum Units: 41.25

Materials Sub-Plan (P3)

- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 370 Principles of Materials Processing F | 3.5
- ENPH 334 Electronics for Applied Scientists F | 5
- ENPH 372 Thermodynamics W | 3.5
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Minimum Units: 42

Mechanical Sub-Plan (P4)

- ENPH 334 Electronics for Applied Scientists F | 5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5

Minimum Units: 41.5

Computing Sub-Plan (P6)

- ELEC 271 Digital Systems F | 4
- ENPH 334 Electronics for Applied Scientists F | 5
- CMPE 320 Fundamentals of Software Development F | 4
- ELEC 274 Computer Architecture W | 4
- ENPH 372 Thermodynamics W | 3.5

Minimum Units: 43

Fourth Year CORE 2023-2024

- ENPH 431 Electromagnetic Theory F | 3.5
- ENPH 454 Advanced Engineering Physics Design Project F | 4.5
- ENPH 455 Engineering Physics Thesis FW | 4
- ENPH 453 Advanced Physics Laboratory W | 3.5

Physics List A:

One from Physics List A:

- ENPH 317 Mathematical Methods in Physics II W | 3.5
- ENPH 321 Advanced Mechanics F | 3.5
- ENPH 414 Introduction to General Relativity W | 3

- ENPH 460 Laser Optics W | 3.5
- ENPH 472 Statistical Mechanics F | 3.5
- ENPH 479 High Performance Computing in Engineering Physics W | 3
- ENPH 480 Solid State Physics F | 3.5
- ENPH 483 Nanoscience and Nanotechnology W | 3.5
- ENPH 490 Nuclear Physics F | 3.5
- ENPH 491 NOT OFFERED 2021-2022 Physics of Nuclear Reactors F | 3.5
- ENPH 495 Introduction to Medical Physics W | 3

Note:

Electrical Sub-Plan (P1)

Two courses from Electrical List B, and one course from Electrical List B or Physics List A, at least one of which must be numbered above 400*:

Electrical List B:

- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 333 Electric Machines W | 4.25
- ELEC 344 Sensors and Actuators F | 3.75
- ELEC 373 Computer Networks W | 3.5
- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- ELEC 409 Bioinformatic Analytics F | 3
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 422 NOT OFFERED 2021-2022 Digital Signal Processing: Random Models and Applications F | 3.5
- ELEC 431 Power Electronics F | 3.25
- ELEC 443 Linear Control Systems F | 4.25
- ELEC 448 Introduction to Robotics: Mechanics and Control F | 3.5
- ELEC 451 Digital Integrated Circuit Engineering F | 3.25
- ELEC 454 NOT OFFERED 2021-2022 Analog Electronics W | 3.25
- ELEC 457 Integrated Circuits and System Applications W | 3.25
- ELEC 461 NOT OFFERED 2021-2022 Digital Communications F | 3.5
- ELEC 464 Wireless Communications F | 3
- ELEC 483 Microwave and RF Circuits and Systems W | 4.25
- ELEC 486 Fiber Optic Communications F | 3.75
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Minimum Units: 36.5

Materials Sub-Plan (P3)

- ENPH 480 Solid State Physics F | 3.5

Materials List B:

Two courses from Materials List B*:

- MECH 437 Fuel Cell Technology F | 3.5
- MECH 423 Introduction to Microsystems W | 3.5
- MECH 470 Deformation Processing W | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 479 Nano-Structured Materials F | 3.5
- MECH 483 Nuclear Materials F | 3.5
- MECH 484 DELETED - Introduction to Ceramics F | 3.5
- CHEE 340 Biomedical Engineering W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a list B course above with a list B course from one of the other options within Engineering Physics.

Minimum Units: 38

Mechanical Sub-Plan (P4)

Three courses: two from Mechanical List B, and one from Physics List A or Mechanical List B*:

Mechanical List B:

- CHEE 340 Biomedical Engineering W | 3.5
- MECH 420 NOT OFFERED 2021-2022 - Vibrations W | 3.5
- MECH 423 Introduction to Microsystems W | 3.5
- MECH 424 NOT OFFERED 2021-2022 - Sustainable Product Design F | 3.5
- MECH 430 NOT OFFERED 2021-2022 - Thermal Systems Design W | 4
- MECH 435 Internal Combustion Engines F | 3.5
- MECH 437 Fuel Cell Technology F | 3.5
- MECH 439 Turbomachinery W | 3.5
- MECH 441 NOT OFFERED 2021-2022 - Fluid Mechanics III W | 3.5
- MECH 444 NOT OFFERED 2021-2022 - Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow W | 3.5

- MECH 452 Mechatronics Engineering F | 5
- MECH 456 Introduction to Robotics F | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 481 NOT OFFERED 2021-2022 - Wind Energy F | 3.5
- MECH 482 Noise Control W | 3.5
- MECH 492 Biological Fluid Dynamics F | 3.5
- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5

Note:

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other options within Engineering Physics.

Minimum Units: 37.5

Computing Sub-Plan (P6)

Three courses: two from Computing List B and one from Physics List A or Computing List B. At least one of the Computing List B courses must be numbered above 400*:

Computing List B:

- CHEE 340 Biomedical Engineering W | 3.5
- CMPE 330 Computer-Integrated Surgery F | 3
- CMPE 365 Algorithms I F | 4
- CMPE 452 Neural Networks and Genetic Algorithms F | 3
- CMPE 454 Computer Graphics W | 3
- CMPE 457 Image Processing and Computer Vision F | 3
- CMPE 458 Programming Language Processors W | 4
- CMPE 472 Medical Informatics W | 3
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- ELEC 409 Bioinformatic Analytics F | 3

Note:

[1]With permission of the instructor.

* Students with the necessary prerequisites and/or permission of the instructor may replace a List B course above with a List B course from one of the other sub-plans within Engineering Physics.

Minimum Units: 36.5

Complementary Studies:

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Engineering Physics Plan, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses in the core plan.

First Year, Engineering and Applied Science

First Year Studies, B.A.Sc.

The first year of study in Engineering and Applied Science is based on a common curriculum and serves as an introduction to all of the academic plans offered by the Faculty. The choice of academic plan the student intends to follow in the second and subsequent years is made in February in the Winter Term of the first year.

Electrical and Computer Engineering Innovation (ECEi) Stream

This program is intended for students with an interest in innovation and entrepreneurship who want to enter electrical or computer engineering in first year. The ECEi focuses on developing entrepreneurial skills alongside the technical and professional elements that are the hallmark of Queen's Engineering.

In the first year of the program students will take broad fundamental courses in math, science, and professional skills supplemented by an entrepreneurial design project specifically designed with for ECEi students. At the end of first year students choose between electrical or computer engineering, and develop strong technical fundamentals and skills necessary for innovation including economics and business practices, design and creativity, and teamwork.

Details about these streams are listed in the calendar at: https://calendar.engineering.queensu.ca/preview_program.php?catoid=8&poid=499&returnto=213

First Year Curriculum

- APSC 100 Engineering Practice l FW | K9
- APSC 199 English Proficiency for Engineers FW, S | K0.2

- APSC 111 Physics I F | 3.3
- APSC 131 Chemistry and Materials F | 3.3

- APSC 143 Introduction to Computer Programming for Engineers F | 3.3
- APSC 151 Earth Systems Engineering F | 3.3
- APSC 171 Calculus I F | 3.3

- APSC 112 Physics II W | 3.3
  or
- APSC 114 Electricity and Magnetism W | 3.3
- APSC 132 Chemistry and its Applications W | 3.3
- APSC 162 Engineering Graphics W | 2.5
- APSC 172 Calculus II W | 3.3
- APSC 174 Introduction to Linear Algebra W, S | 3.3
- APSC 182 Applied Engineering Mechanics W, F, S | 1.7

Minimum Total Credits: 43.1

First Year Advice and Counseling

First Year students looking for academic advice and counseling are encouraged to contact the Program Associate, Student Services, Faculty of Engineering and Applied Science by phone at 533-2055 or by email at engineering.first.year@queensu.ca.

The Douglas Help Desk

A gift from Dr. James Douglas (Queen's BA, 1858) in 1910 made possible the establishment of a program by which First Year students are tutored by students selected from senior years. Details are available in the Faculty Office, and on the web at http://engineering.queensu.ca/Current-Students/First-Year-Studies/DouglasTutorials.html

The Engineering Society (EngSoc) Engvents

The EngSoc Engvents The Engvents Committee's mandate is to connect engineering students of all years and disciplines through team based competitions and social events hosted throughout the year. Past events have included paintballing, dodgeball tournaments, bowling nights, amazing race style scavenger hunts, and even a Boat Cruise on Lake Ontario! So come on out, connect with fellow engineers, and have a great time with Engvents! If you have any questions or would like to get involved with Engvents, contact engvents@engsoc.queensu.ca.

The Engineering Society (EngSoc) 'EngLinks' Tutoring System

For help using the EngSoc 'EngLinks' Tutoring System, see http://englinks.ca/

The Extended Program

The Extended Program provides an opportunity for First Year students who experience difficulties with the introductory courses APSC 111, APSC 131, and/or APSC 171 in the fall semester to retake these courses in the winter semester. Registration in the Extended Program takes place in early January. The courses normally completed in December are reviewed, and final examinations are rewritten in February during Reading Week. Instruction in the second term courses in APSC 112, APSC 132, APSC 172 and APSC 174 begins after Reading Week, is suspended when regular Winter term lectures end, and resumes after the normal examination period. These second term courses are completed in June. There is a special fee for each course in the Spring term (see the Section on Fees) *

Orientation Nights

In late January and early February each department holds an Orientation Night for first year students to introduce them to the department and to its academic plan(s). Students are encouraged to attend as many of these evening seminars as possible to help them make their plan choice. Help in reaching a decision regarding future studies can also be obtained in private discussions with upper year students, instructors, and the Program Associate, Student Services in the Faculty Office. Help is available on web pages maintained the departments in the Faculty (see http://engineering.queensu.ca/Current-Students/First-Year-Studies/DisciplineOrientationSchedule.html).

Choice of Program: Preregistration

First year students preregister in February to indicate the academic plan in which they intend to register in the academic year. A student will be admitted to the plan of their choice, provided the first year requirements have been met. Having preregistered in one plan, it may be possible to apply to transfer to another at a later date. However, such a change must be approved, in advance, by the department offering the academic plan in which the student wishes to register.

Admission to a Second Year Program

The rules governing the admission to the second year are given in the Faculty Regulations Section: in particular, Regulations 2f, 2g, and 10. Briefly, if a student has passed all of the courses in the First Year plan with marks of 1.6 ECGPA or better, admission to the second year will be unconditional. Otherwise, there may be constraints. Advice should be sought from the Faculty Office, or from the Chair of Undergraduate Studies in the program of choice.

Geological Engineering

Department Head Dr. V.H. Remenda, PEng.
Chair of Undergraduate Studies Dr. M. Diederichs, PEng, FEIC
Undergraduate Faculty Advisor Dr. G. Fotopoulos, PEng,
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Geological Engineering is a broad and creative field of engineering which combines practical application of geological principles, concepts and techniques with engineering investigation, analysis and design, providing reliable and sustainable engineered solutions to human needs.

Geological Engineering at Queen's University prepares students for the creative problem solving, analysis, interpretation and decision making necessary to tackle engineering challenges related to:

- Design and application of advanced surface and subsurface investigation, field and lab data interpretation, advanced analysis and geological modelling in aid of engineering design;
- Environmental engineering including subsurface water resource exploration and protection, ground contaminant remediation, sustainable mine/urban/industrial waste management/engineering;
- Geotechnical engineering and construction on, with or through earth materials (rock and soil) including tunnels, caverns, mines, transportation infrastructure, foundations, dams, waste storage;
- Geo-hazard assessment and risk mitigation including landslides, subsidence, earthquakes and floods;
- Mineral and energy resource exploration, evaluation, development and sustainable management, including environmental protection and remediation before, during and after geo-resource extraction;
- Applied Geophysics (eg. Seismics, electro-magnetics, gravity, laser, radar, etc) for remote probing (from the ground or from space) and visualization of the subsurface environment to facilitate geotechnical, geo-hazard, geo-environmental or geo-resource engineering.

The academic plan provides an enhanced understanding of the geological model associated with a particular challenge from the list above allowing in-depth assessment and understanding of the engineering properties of earth materials, including natural variability within and between different environments, sensitivity of these materials to genesis and tectonic history, the changes to earth materials with time within an engineering context, and the impacts on the reliability and sustainability of design solutions.

The Geological Engineering plan offers a common second year curriculum, to provide students with a foundation in geological sciences, math and physics in addition to broad introductory exposure to a variety of geo-engineering problems and design approaches. The extensive and well-rounded core program offered in third and fourth year is augmented by a number of technical elective choices. This allows each student to gain in-depth specialization by taking several courses in an area of interest, geotechnical engineering, geo-environmental engineering, including mineral and energy exploration, or geophysics. Alternatively, a student can choose to build a breadth of knowledge across the discipline of Geological Engineering.

Geological Engineering Curriculum

It is recommended that students consult the academic advisor at least once in each year of their plan, to ensure that they are taking the required number of Technical Electives and Complementary Studies courses to fulfill the academic plan requirements as well as those of the Canadian Engineering Accreditation Board. Students need to plan ahead to ensure that they take courses in the appropriate years along with the necessary prerequisites.

Revisions to the Geological Engineering plan are ongoing. There are separate sections for the Classes of 2017, 2018, and 2019. Please refer to the appropriate calendar for your year of graduation.

The Technical Elective (TE) List is given at the end of this section. Complementary Studies (CE) are discussed at the end of each year calendar entry. For the classes of 2018 and 2019, students may take elective courses (4 TE and 3 CE) in any of the elective slots available in the 3rd and 4th years of the plan. For the class of 2017, a total of 5 TE and 3 CE are required.

Field Work

Field work is an essential part of Geological Engineering training, both to gain field skills and to understand the sources and nature of the data to be used for analysis and design. Field trips and field projects are offered in each year of study because the Department wishes to provide the best experience-based education possible. Employers and alumni from the Department are universally enthusiastic about the value of this component of the Geological Engineering plan. In accordance with University policies, students will receive specialized instruction in field safety.

A field skills course, with trips around the Kingston area, is undertaken during the fall term of second year. A two-week Geological Engineering field school is held in the spring immediately following final exams. Students are expected to take this course at the end of their second year. This course requires teams of students to design and carry out geological and engineering site investigations related to specific geological engineering problems. Core field courses in fourth year deal either with engineering and design issues related to geo-environmental, geotechnical and resource management issues within the mineral industry, or with engineering site investigation design using applied geophysics.

The cost of field trips and courses, including transportation, accommodation and food (when it is supplied), will be borne by the student. A list of the field education costs for each course is provided on the departmental web page (*http://www.queensu.ca/geol/undergrad/field-trips*).

These costs are subject to change, and will be finalized by June 1 each year for the following academic year. These costs will be payable by the due dates listed in the table. Subsidies will be provided by the Department when funding permits.

Students may incur additional field trip costs for courses they elect to take as a part of their degree. Students should consult with course instructors regarding these costs before registering in courses with a field trip component.

Geological Engineering, B.A.Sc. (Class of 2022)

Second Year CORE 2019-2020

- APSC 200 Engineering Design and Practice II F/W | K4 *
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3 *
- APSC 293 Engineering Communications l F/W | K1 *
- CHEE 209 Analysis of Process Data F | 3.5
- CIVL 230 Solid Mechanics I F | 4.25
- GEOE 207 History of Life F | 3.5
- GEOE 221 Geological Engineering Field Methods F | 5
- GEOE 232 Mineralogy F | 4.5
- GEOE 235 Genesis and Characterization of Solid Earth Materials W | 4
- GEOE 238 Surficial Processes, Sedimentation and Stratigraphy W | 4
- GEOE 249 Geophysical Characterization of the Earth W | 3.5
- GEOE 281 Introduction to Geological Engineering F | 3.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5 *
  *Note: Students in GEOE take APSC 221, APSC 200, APSC 293 and MTHE 225 in the Winter term.

Minimum Total Credits: 47.25

Intersession (Taken at the end of August before 3rd year)

- GEOE 300 Geological Engineering Field School F | K4

Third Year CORE 2020-2021

- CIVL 340 Geotechnical Engineering I F | 3.75
- GEOE 313 Engineering Geology and Geomechanics W | 3.5
- GEOE 319 Applied Geophysics W | 4.5
- GEOE 321 Analysis of Rock Structures F | 4
- GEOE 333 Terrain Evaluation W | 4
- GEOE 343 Applied Hydrogeology F | 3.5
- GEOE 345 Site Investigation & Geological Engineering Design W | 4
- GEOE 359 Applied Quantitative Analysis in Geological Engineering F | 3.5
- GEOE 362 Resource Engineering W | 4.5
- GEOE 365 Geochemical Characterization of the Earth F | 4
- Technical Elective F/W | 3.5

Minimum Total Credits: 42.75

Fourth Year CORE 2021-2022

GEOE 410 or GEOE 419 will be taken prior to the start of fourth year at the end of August

Take ONE of GEOE 410 or GEOE 419 as Core (* below)

- GEOE 410 NOT OFFERED 2021-2022 Geological Engineering Field School F | K4 *
- GEOE 419 Engineering Geophysics Field School F | K4 *
- GEOE 446 Engineering Design Project I F | K4
- GEOE 447 Engineering Design Project II W | K5.5
- Technical Elective F/W | 3.5
- Technical Elective F/W | 3.5
- Technical Elective F/W | 3.5
- Technical Elective F/W | 3.5
- Complementary Studies Elective F/W | 3
- Complementary Studies Elective F/W | 3
- Complementary Studies Elective F/W | 3

Minimum Total Credits: 36.5

*Note: (GEOE 410/GEOL 419 are not offered in August 2021. Students who are graduating in the spring of 2022 should take an additional Technical Elective from the following: APSC381, CIVL215, CIVL250, CIVL341, CIVL443, GEOE462, MECH 270, MINE321, MINE467).

Electives (Class of 2022)

The Geological Engineering student requires a total of 17.5 TECHNICAL ELECTIVE (TE) CREDITS (210 AUs). These are typically, (but not exclusively) taken as 5 TE elective courses with a minimum average of 3.5 Credits or 42 AUs per course. These courses can be taken at any point during the program to accommodate timetabling but normally only in third and fourth year. Students should plan to ensure that prerequisite and corequisite requirements are met for the full suite of TE or CS electives they wish to take during their program. Students should note that a reduction of total course load to less than 80% of the normal load may prevent them from holding Queen's University scholarships.

It is mandatory that at least 3.5 Credits of Technical Electives (TE) be taken from the following list: APSC 381, APSC 480, CIVL 215, CIVL 250, CIVL 341, CIVL 443, CIVL 471, GEOE 413, GEOE 462, MECH 270, MINE 321, MINE 467 or MINE 469.

Geological Engineering: Technical Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for courses that may be taken for all Engineering programs. For the Geological Engineering Program, the Engineering Economics course is APSC 221 , and the Communications course is APSC 293 in addition to first year program and the three Complementary Studies courses (as above): 3 credits from List A and 6 credits from Lists A or B.

Geological Engineering, B.A.Sc. (Class of 2023)

Second Year CORE – 2020-2021

- APSC 200 Engineering Design and Practice II F/W | K4 *
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3 *
- APSC 293 Engineering Communications l F/W | K1 *
- CHEE 209 Analysis of Process Data F | 3.5
- CIVL 230 Solid Mechanics I F | 4.25
- GEOE 207 History of Life F | 3.5
- GEOE 221 Geological Engineering Field Methods F | 5
- GEOE 232 Mineralogy F | 4.5
- GEOE 235 Genesis and Characterization of Solid Earth Materials W | 4
- GEOE 238 Surficial Processes, Sedimentation and Stratigraphy W | 4
- GEOE 249 Geophysical Characterization of the Earth W | 3.5
- GEOE 281 Introduction to Geological Engineering F | 3.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5 *
  *Note: Students in GEOE take APSC 221, APSC 200, 293 and MTHE 225 in the Winter term.

Minimum Total Credits: 46.75

*Note: GEOE 300 will be taken August 2022, prior to 4^{th} year due to Covid-19 setbacks.

Third Year CORE – 2021-2022

- CIVL 340 Geotechnical Engineering I F | 3.75
- GEOE 300 Geological Engineering Field School F | K4 *
- GEOE 313 Engineering Geology and Geomechanics W | 3.5
- GEOE 319 Applied Geophysics W | 4.5
- GEOE 321 Analysis of Rock Structures F | 4
- GEOE 333 Terrain Evaluation W | 4
- GEOE 343 Applied Hydrogeology F | 3.5
- GEOE 345 Site Investigation & Geological Engineering Design W | 4
- GEOE 359 Applied Quantitative Analysis in Geological Engineering F | 3.5
- GEOE 362 Resource Engineering W | 4.5
- GEOE 365 Geochemical Characterization of the Earth F | 4
- Technical Elective F/W | 3.5

Minimum Total Credits: 42.75

* Please note in 3rd year *GEOE 300 will be taken in late August.

Fourth Year CORE - 2022-2023

GEOE 410 or GEOE 419 will be taken prior to the start of fourth year at the end of August

Take ONE of GEOE 410 or GEOE 419 as Core (* below)

- GEOE 410 NOT OFFERED 2021-2022 Geological Engineering Field School F | K4 *
- GEOE 419 Engineering Geophysics Field School F | K4 *
- GEOE 446 Engineering Design Project I F | K4
- GEOE 447 Engineering Design Project II W | K5.5
- Technical Elective F/W | 3.5
- Technical Elective F/W | 3.5
- Technical Elective F/W | 3.5
- Technical Elective F/W | 3.5
- Complementary Studies Elective F/W | 3
- Complementary Studies Elective F/W | 3
- Complementary Studies Elective F/W | 3

Minimum Total Credits: 36.5

Electives (Class of 2022)

The Geological Engineering student requires a total of 17.5 TECHNICAL ELECTIVE (TE) CREDITS (210 AUs). These are typically, (but not exclusively) taken as 5 TE elective courses with a minimum average of 3.5 Credits or 42 AUs per course. These courses can be taken at any point during the program to accommodate timetabling but normally only in third and fourth year. Students should plan to ensure that prerequisite and corequisite requirements are met for the full suite of TE or CS electives they wish to take during their program. Students should note that a reduction of total course load to less than 80% of the normal load may prevent them from holding Queen's University scholarships.

It is mandatory that at least 3.5 Credits of Technical Electives (TE) be taken from the following list: APSC 381, APSC 480, CIVL 215, CIVL 250, CIVL 341, CIVL 443, CIVL 471, GEOE 413, GEOE 462, MECH 270, MINE 321, MINE 467 or MINE 469.

Geological Engineering: Technical Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for courses that may be taken for all Engineering programs. For the Geological Engineering Program, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 in addition to first year program and the three Complementary Studies courses (as above): 3 credits from List A and 6 credits from Lists A or B.

Geological Engineering, B.A.Sc. (Class of 2024)

Second Year CORE 2021-2022

- APSC 200 Engineering Design and Practice II F/W | K4 *
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3 *
- APSC 293 Engineering Communications l F/W | K1 *
- CHEE 209 Analysis of Process Data F | 3.5
- CIVL 230 Solid Mechanics I F | 4.25
- GEOE 207 History of Life F | 3.5
- GEOE 221 Geological Engineering Field Methods F | 5
- GEOE 232 Mineralogy F | 4.5
- GEOE 235 Genesis and Characterization of Solid Earth Materials W | 4
- GEOE 238 Surficial Processes, Sedimentation and Stratigraphy W | 4
- GEOE 249 Geophysical Characterization of the Earth W | 3.5
- GEOE 281 Introduction to Geological Engineering F | 3.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5 *
  *Note: Students in GEOE take APSC 221, APSC 200, APSC 293 and MTHE 225 in the Winter term

Minimum Units: 47.25

Intersession (Taken at the end of August before 3rd Year)

- GEOE 300 Geological Engineering Field School F | K4

Third Year CORE 2022-2023

- CIVL 340 Geotechnical Engineering I F | 3.75
- GEOE 313 Engineering Geology and Geomechanics W | 3.5
- GEOE 319 Applied Geophysics W | 4.5
- GEOE 321 Analysis of Rock Structures F | 4
- GEOE 333 Terrain Evaluation W | 4
- GEOE 343 Applied Hydrogeology F | 3.5
- GEOE 345 Site Investigation & Geological Engineering Design W | 4
- GEOE 359 Applied Quantitative Analysis in Geological Engineering F | 3.5
- GEOE 362 Resource Engineering W | 4.5

- GEOE 365 Geochemical Characterization of the Earth F | 4
- Technical Elective F/W | 3.5

Minimum Units: 43.25

Fourth Year CORE 2023-2024

GEOE 410 or GEOE 419 will be taken prior to the start of fourth year at the end of August

Take ONE of GEOE 410 or GEOE 419 as Core (* below)

- GEOE 410 NOT OFFERED 2021-2022 Geological Engineering Field School F | K4 *
- GEOE 419 Engineering Geophysics Field School F | K4 *
- GEOE 446 Engineering Design Project I F | K4
- GEOE 447 Engineering Design Project II W | K5.5
- Technical Elective F/W | 3.5
- Technical Elective F/W | 3.5
- Technical Elective F/W | 3.5
- Technical Elective F/W | 3.5
- CS Elective F/W | 3
- CS Elective F/W | 3

Minimum Units: 33.5

Electives (Classes of 2021)

The Geological Engineering student requires a total of 17.5 TECHNICAL ELECTIVE (TE) CREDITS (210 AUs). These are typically, (but not exclusively) taken as 5 TE elective courses with a minimum average of 3.5 Credits or 42 AUs per course. These courses can be taken at any point during the program to accommodate timetabling but normally only in third and fourth year. Students should plan to ensure that prerequisite and corequisite requirements are met for the full suite of TE or CS electives they wish to take during their program. Students should note that a reduction of total course load to less than 80% of the normal load may prevent them from holding Queen's University scholarships.

It is mandatory that at least 3.5 Credits of Technical Electives (TE) be taken from the following list: APSC 381, APSC 480, CIVL 215, CIVL 250, CIVL 341, CIVL 443, CIVL 471, GEOE 413, GEOE 462, MECH 270, MINE 321, MINE 467 or MINE 469.

Geological Engineering: Technical Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for courses that may be taken for all Engineering programs. For the Geological Engineering Program, the Engineering Economics course is APSC 221, and the Communications course is APSC 293 in addition to first year program and the three Complementary Studies courses (as above): 3 credits from List A and 6 credits from Lists A or B.

Geological Engineering: Technical Electives

All courses on this list can be counted as Technical Elective unless they have already been taken as core. Some of these elective courses may not be available to all students due to prerequisite course requirements. Some courses are offered in alternating years. The student is responsible for confirming that he/she has the necessary prerequisites or permission of the instructor. For some courses that are part of other program cores and subject to internal enrollment restrictions, permission of the instructor may be required even if prerequisites are met. Other technical courses (courses with level 200+ that do not appear in the complimentary studies list for APSC) may be considered as eligible Technical Electives with the permission of the GEOE academic advisor and GEOE curriculum chair, and if the instructor of the course permits the student to register.

Technical Electives List

- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- APSC 303 Professional Internship | 3.5 *Pending successful completion of Queen's Internship Program (QUIP)
- APSC 381 Advanced Design and Skills for Innovation W | K3.5
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
- CHEE 324 NOT OFFERED 2021-2022 Organic Process Development W | 3.5
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- CIVL 215 Materials for Civil Engineers W | 4.5
- CIVL 231 Solid Mechanics II W | 4.5
- CIVL 250 Hydraulics I W | 4
- CIVL 350 Hydraulics II F | 3.75
- CIVL 340 Geotechnical Engineering I F | 3.75
- CIVL 341 Geotechnical Engineering II W | 4
- CIVL 371 Groundwater Engineering F | 3.75
- CIVL 442 Geotechnical Design F | 3.75
- CIVL 443 Geoenvironmental Design W | 4
- CIVL 451 Lake, Reservoir and Coastal Engineering F | 3.75
- CIVL 455 River Engineering F | 4
- CIVL 471 Subsurface Contamination F | 4
- CHEE 484 NOT OFFERED 2021-2022 Bioremediation W | 3.5
- CMPE 320 Fundamentals of Software Development F | 4

- ELEC 210 DELETED Introductory Electric Circuits and Machines W | 4.25
- ELEC 221 Electric Circuits F | 4.25
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 279 Introduction to Object Oriented Programming W | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 381 Applications of Electromagnetics W | 3.75
- ENCH 213 Introduction to Chemical Analysis F | 4.75
- ENPH 225 Mechanics W | 3.5
- ENPH 239 Electricity and Magnetism W | 3.5
- ENPH 334 Electronics for Applied Scientists F | 5
- GEOE 301 Field Studies in Geology F | 1.5
- GEOE 337 Paleontology F | 3.75
- GEOE 340 Problems in Geological Engineering F/W | 3
- GEOE 341 Special Topics in Applied Geology F/W/S | 3
- GEOE 343 Applied Hydrogeology F | 3.5
- GEOE 368 Carbonate Sedimentology F | 4.5
- GEOE 401 Field Studies in Geology II F | 1.5
- GEOE 410 NOT OFFERED 2021-2022 Geological Engineering Field School F | K4
- GEOE 414 Foundations of the Oil and Gas Industry W | 3.5
- GEOE 418 Petroleum Geology F | 4.5
- GEOE 419 Engineering Geophysics Field School F | K4
- GEOE 439 Advanced Applied Geophysics F | K3
- GEOE 452 Instrumental Techniques Applied to the Study of Solids W | 3
- GEOE 462 Advanced Petrogenesis and Metallogenesis W | 4.5
- GEOE 463 Spatial Information Management in the Geosciences F | 3.5
- GEOE 464 Visualization in Geosciences W | 1.5
- GEOE 466 Isotopes and the Environment W | 4
- GEOE 475 Exploration and Environmental Geochemistry F | 4.3
- GEOE 478 Terrigeneous Clastic Sedimentology F | 3.5
- GEOE 481 Structural Analysis Applied to Resource Deposits W | 3.5
- GEOE 488 Geology of North America F | 3
- GPHY 304 Arctic and Periglacial Environments W | 3
- MINE 321 Drilling and Blasting F | 4.5
- MINE 330 Mineral Industry Economics F | 3.5
- MINE 335 Mineral Processing F | 3
- MINE 422 Mining and Sustainability F | 4
- MINE 467 Geostatistics and Orebody Modelling F | 4.5
- MINE 469 DELETED - Stability Analysis in Mine Design F | 4
- MNTC 408 Mine Health and Safety O/L | 3
- MTHE 227 Vector Analysis F | 3
- MTHE 228 Complex Analysis W | 3.5
- MTHE 339 Evolutionary Game Theory W | 3
- ENPH 242 Relativity and Quanta F | 3.5
- MECH 228 Kinematics and Dynamics W | K3.5

- MECH 230 Applied Thermodynamics I F | 3.5
- MECH 270 Materials Science and Engineering F | 3.5
- MINE 459 Risk and Reliability Analysis for Industrial Asset Management, Health & Safety F | 4

Mathematics and Engineering

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This plan was developed at Queen's in response to the need for engineers who possess the skills and insights of applied mathematicians. In the second and third years of the plan, half of the curriculum consists of honours courses in pure and applied mathematics; the balance consists of engineering courses in one of three sub-plans offered in cooperation with the departments of Mechanical, Electrical and Computer Engineering, and the School of Computing. The sub-plans are developed with appropriate applications of mathematics to engineering in the final year. The sub-plans are:

(M6) APPLIED MECHANICS: (mechanics, dynamics, fluid mechanics, thermodynamics)

(M9) COMPUTING AND COMMUNICATIONS: (computer science, software design, communication, information systems, and electrical engineering)

(M11) SYSTEMS AND ROBOTICS: (electrical and mechanical engineering, control, communications, information systems, robotics, and mechanics)

Options available:

- Applied Mechanics Option
- Computing and Communications Option
- Systems and Robotics Option

Mathematics and Engineering, B.A.Sc. (Class of 2022)

Second Year CORE 2019/2020

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- MTHE 212 Linear Algebra W | 3.5

- MTHE 217 Algebraic Structures with Applications F | 3.5
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- MTHE 280 Advanced Calculus F | 3.5
- MTHE 281 Introduction to Real Analysis W | 3.5

Applied Mechanics Sub-Plan (M6)

- ENPH 252 Management of Experimental Data W | 1.25
- MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5
- MECH 221 Solid Mechanics I F, O/L | 4
- MECH 228 Kinematics and Dynamics W | K3.5
- MECH 230 Applied Thermodynamics I F | 3.5
- MECH 241 Fluid Mechanics I W/S/OL | 3.5

Minimum Total Credits: 42.5

Computing and Communications Sub-Plan (M9)

- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ENPH 239 Electricity and Magnetism W | 3.5

Minimum Total Credits: 41.75

Systems and Robotics Sub-Plan (M11)

- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ENPH 225 Mechanics W | 3.5

Minimum Total Credits: 42.25

Third Year CORE 2020/2021

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MTHE 326 Functions of a Complex Variable F | 3.5
- MTHE 332 Introduction to Control W | 4
- MTHE 334 Mathematical Methods for Engineering and Physics F | 3.5

- MTHE 335 Mathematics of Engineering Systems W | 3.5
- MTHE 393 Engineering Design and Practice for Mathematics and Engineering W | K4

Applied Mechanics Sub-Plan (M6)

- MECH 321 Solid Mechanics II F | 3.5
- MECH 323 Machine Design W | 4.5
- MECH 328 Dynamics and Vibration F | 3.5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 42

Computing and Communications Sub-Plan (M9)

- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- MTHE 351 Probability I F | 3.5
- MTHE 353 Probability II W | 3
- CMPE 365 Algorithms I F | 4
- CMPE 332 Database Management Systems W | 3

Minimum Total Credits: 39

Systems and Robotics Sub-Plan (M11)

- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ENPH 239 Electricity and Magnetism W | 3.5
- MTHE 351 Probability I F | 3.5
- MTHE 353 Probability II W | 3
- Complementary Studies, List A F/W | 3

Minimum Total Credits: 42.5

Fourth Year CORE 2021/2022

- MTHE 493 Engineering Mathematics Project FW | K7.5
- MTHE 494 Mathematics and Engineering Seminar F | 3

Applied Mechanics Sub-Plan (M6)

- MTHE 351 Probability I F | 3.5
- MTHE 430 Modern Control Theory F | 4
- MTHE 439 Lagrangian Mechanics, Dynamics, and Control W | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A or B F/W | 3
- Complementary Studies, List A or B F/W | 3

Electives

M6 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and
2. the selection exceeds the minimum of 120 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Applied Mechanics (M6): Technical Electives

Minimum Total Credits: 42.5

Computing and Communications Sub-Plan (M9)

- MTHE 455 Stochastic Processes and Applications F | 3.5
- MTHE 474 Information Theory F | 3
- MTHE 477 Data Compression and Source Coding W | 3
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A or B F/W | 3
- Complementary Studies, List A or B F/W | 3

Electives

M9 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and

2. the selection exceeds the minimum of 100 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Computing and Communications (M9): Technical Electives

Minimum Total Credits: 41

Systems and Robotics Sub-Plan (M11)

- MTHE 430 Modern Control Theory F | 4
- MTHE 474 Information Theory F | 3
- MTHE 472 Control of Stochastic Systems W | 3
- Complementary Studies, List A or B F/W | 3
- Complementary Studies, List A or B F/W | 3

Electives

M11 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and

2. the selection exceeds the minimum of 120 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Systems and Robotics (M11): Technical Electives

Minimum Total Credits: 38.5

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mathematics and Engineering Program, the

Engineering Economics course is APSC 221 , and the Communications requirements are met through courses taken in the core program (MTHE 393 , MTHE 494 , MTHE 493 and APSC 293

Mathematics and Engineering, B.A.Sc. (Class of 2023)

Second Year Common Core - 2020-2021

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- MTHE 212 Linear Algebra W | 3.5
- MTHE 217 Algebraic Structures with Applications F | 3.5
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- MTHE 280 Advanced Calculus F | 3.5
- MTHE 281 Introduction to Real Analysis W | 3.5

Applied Mechanics Sub-Plan (M6)

- ENPH 252 Management of Experimental Data W | 1.25
- MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5
- MECH 221 Solid Mechanics I F, O/L | 4
- MECH 228 Kinematics and Dynamics W | K3.5
- MECH 230 Applied Thermodynamics I F | 3.5
- MECH 241 Fluid Mechanics I W/S/OL | 3.5

Minimum Total Credits: 42.5

Computing and Communications Sub-Plan (M9)

- CMPE 212 Introduction to Computing Science II F/W | 4
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ENPH 239 Electricity and Magnetism W | 3.5

Minimum Total Credits: 41.75

Systems and Robotics Sub-Plan (M11)

- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4

- ENPH 225 Mechanics W | 3.5

Minimum Total Credits: 42.25

Third Year Common Core - 2021-2022

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MTHE 326 Functions of a Complex Variable F | 3.5
- MTHE 332 Introduction to Control W | 4
- MTHE 334 Mathematical Methods for Engineering and Physics F | 3.5
- MTHE 335 Mathematics of Engineering Systems W | 3.5
- MTHE 393 Engineering Design and Practice for Mathematics and Engineering W | K4

Applied Mechanics Sub-Plan (M6)

- MECH 321 Solid Mechanics II F | 3.5
- MECH 323 Machine Design W | 4.5
- MECH 328 Dynamics and Vibration F | 3.5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 44

Computing and Communications Sub-Plan (M9)

- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- MTHE 351 Probability I F | 3.5
- MTHE 353 Probability II W | 3
- CMPE 365 Algorithms I F | 4
- CMPE 320 Fundamentals of Software Development F | 4
- CMPE 332 Database Management Systems W | 3

Minimum Total Credits: 43

Systems and Robotics Sub-Plan (M11)

- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ENPH 239 Electricity and Magnetism W | 3.5
- MTHE 351 Probability I F | 3.5

- MTHE 353 Probability II W | 3
- Complementary Studies, List A F/W | 3

Minimum Total Credits: 42.5

Fourth Year Common Core - 2022-2023

- MTHE 493 Engineering Mathematics Project FW | K7.5
- MTHE 494 Mathematics and Engineering Seminar F | 3

Applied Mechanics Sub-Plan (M6)

- MTHE 430 Modern Control Theory F | 4
- MTHE 351 Probability I F | 3.5
- MTHE 439 Lagrangian Mechanics, Dynamics, and Control W | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A or B F/W | 3
- Complementary Studies, List A or B F/W | 3

Electives

M6 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and
2. the selection exceeds the minimum of 120 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Applied Mechanics (M6): Technical Electives

Minimum Total Credits: 42.5

Computing and Communications Sub-Plan (M9)

- MTHE 474 Information Theory F | 3
- MTHE 455 Stochastic Processes and Applications F | 3.5
- MTHE 477 Data Compression and Source Coding W | 3
- Complementary Studies, List A F/W | 3

- Complementary Studies, List A or B F/W | 3
- Complementary Studies, List A or B F/W | 3

Electives

M9 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:
1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and
2. the selection exceeds the minimum of 100 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Computing and Communications (M9): Technical Electives

Minimum Total Credits: 41

Systems and Robotics Sub-Plan (M11)

- MTHE 430 Modern Control Theory F | 4
- MTHE 474 Information Theory F | 3
- MTHE 472 Control of Stochastic Systems W | 3
- Complementary Studies, List A or B F/W | 3
- Complementary Studies, List A or B F/W | 3

Electives

M11 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:
1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and
2. the selection exceeds the minimum of 120 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Systems and Robotics (M11): Technical Electives

Minimum Total Credits: 38.5

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mathematics and Engineering Program, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses taken in the core program (MTHE 393, MTHE 494, MTHE 493 and APSC 293).

Mathematics and Engineering, B.A.Sc. (Class of 2024)

Second Year Common Core - 2021-2022

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- MTHE 217 Algebraic Structures with Applications F | 3.5
- MTHE 237 Differential Equations for Engineering Science F | 3.25
- MTHE 280 Advanced Calculus F | 3.5
- MTHE 281 Introduction to Real Analysis W | 3.5
- MTHE 212 Linear Algebra W | 3.5

Applied Mechanics Sub-Plan (M6)

- MECH 221 Solid Mechanics I F, O/L | 4
- MECH 230 Applied Thermodynamics I F | 3.5
- ENPH 252 Management of Experimental Data W | 1.25
- MECH 228 Kinematics and Dynamics W | K3.5
- MECH 241 Fluid Mechanics I W/S/OL | 3.5
- MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5

Minimum Total Credits: 42.5

Computing and Communications Sub-Plan (M9)

- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ENPH 239 Electricity and Magnetism W | 3.5
- CMPE 212 Introduction to Computing Science II F/W | 4

- ELEC 278 Fundamentals of Information Structures F | 4

Minimum Total Credits: 41.75

Systems and Robotics Sub-Plan (M11)

- ELEC 221 Electric Circuits F | 4.25
- ELEC 271 Digital Systems F | 4
- ENPH 225 Mechanics W | 3.5
- ELEC 252 Electronics I W | 4.25
- ELEC 274 Computer Architecture W | 4

Minimum Total Credits: 42.25

Third Year Common Core - 2022-2023

- MTHE 326 Functions of a Complex Variable F | 3.5
- MTHE 332 Introduction to Control W | 4
- MTHE 334 Mathematical Methods for Engineering and Physics F | 3.5
- MTHE 335 Mathematics of Engineering Systems W | 3.5
- MTHE 393 Engineering Design and Practice for Mathematics and Engineering W | K4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3

Applied Mechanics Sub-Plan (M6)

- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 323 Machine Design W | 4.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 44

Computing and Communications Sub-Plan (M9)

- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- MTHE 351 Probability I F | 3.5
- MTHE 353 Probability II W | 3
- CMPE 320 Fundamentals of Software Development F | 4
- CMPE 332 Database Management Systems W | 3

- CMPE 365 Algorithms I F | 4

Minimum Total Credits: 43

Systems and Robotics Sub-Plan (M11)

- MTHE 351 Probability I F | 3.5
- ELEC 278 Fundamentals of Information Structures F | 4
- ENPH 239 Electricity and Magnetism W | 3.5
- MTHE 353 Probability II W | 3
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- Complementary Studies, List A F/W | 3

Minimum Total Credits: 42.5

Fourth Year Common Core - 2023-2024

- MTHE 494 Mathematics and Engineering Seminar F | 3
- MTHE 493 Engineering Mathematics Project FW | K7.5

Applied Mechanics Sub-Plan (M6)

- MTHE 430 Modern Control Theory F | 4
- MTHE 351 Probability I F | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A or B F/W | 3
- Complementary Studies, List A or B F/W | 3
- MTHE 439 Lagrangian Mechanics, Dynamics, and Control W | 3.5

Elective

M6 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and
2. the selection exceeds the minimum of 120 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.

Mathematics and Engineering, Applied Mechanics (M6): Technical Electives

Minimum Total Credits: 42.5

Computing and Communications Sub-Plan (M9)

- MTHE 474 Information Theory F | 3
- MTHE 455 Stochastic Processes and Applications F | 3.5
- Complementary Studies, List A F/W | 3
- Complementary Studies, List A or B F/W | 3
- Complementary Studies, List A or B F/W | 3
- MTHE 477 Data Compression and Source Coding W | 3

Elective

M9 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and

2. the selection exceeds the minimum of 100 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: *the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.*

Mathematics and Engineering, Computing and Communications (M9): Technical Electives

Minimum Total Credits: 41

Systems and Robotics Sub-Plan (M11)

- MTHE 430 Modern Control Theory F | 4
- MTHE 472 Control of Stochastic Systems W | 3
- MTHE 474 Information Theory F | 3
- Complementary Studies, List A or B F/W | 3
- Complementary Studies, List A or B F/W | 3

Elective

M11 students must choose 4 technical electives: a minimum of one (1) technical elective must be taken from List I; and the remaining from List II, subject to the requirement that the elective selection satisfies the following two criteria:

1. the selection exceeds the minimum of 40 Accreditation Units (AUs) in Engineering Design (ED) and

2. the selection exceeds the minimum of 120 AUs in Engineering Design + Engineering Science (ES+ED).

PLEASE NOTE: *the term in which a course is offered can change from one academic year to the next. This can occur due to instructor availability or a change to departmental resources. Please refer to the on-line Course Timetable to determine the terms in which the courses in this Technical Elective section will be offered.*

Mathematics and Engineering, Systems and Robotics (M11): Technical Electives

Minimum Total Credits: 38.5

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mathematics and Engineering Program, the Engineering Economics course is APSC 221, and the Communications requirements are met through courses taken in the core program (MTHE 393, MTHE 494, MTHE 493 and APSC 293

Mathematics and Engineering, Applied Mechanics (M6): Technical Electives

List I:

(choose AT LEAST ONE course)

- MTHE 353 Probability II W | 3
- MTHE 406 NOT OFFERED 2021-2022 - Introduction to Coding Theory F | 3
- MTHE 418 Number Theory and Cryptography W | 3
- MTHE 434 Optimization Theory with Applications to Machine Learning W | 3.5
- MTHE 472 Control of Stochastic Systems W | 3
- MTHE 433 Continuum Mechanics with Applications W | 3
- MTHE 437 Topics in Applied Mathematics W | 3.5

List II:

- MECH 346 Heat Transfer W | 3.5
- MECH 420 NOT OFFERED 2021-2022 - Vibrations W | 3.5

- MECH 424 NOT OFFERED 2021-2022 - Sustainable Product Design F | 3.5
- MECH 435 Internal Combustion Engines F | 3.5
- MECH 439 Turbomachinery W | 3.5
- MECH 441 NOT OFFERED 2021-2022 - Fluid Mechanics III W | 3.5
- MECH 444 NOT OFFERED 2021-2022 - Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow W | 3.5
- MECH 452 Mechatronics Engineering F | 5
- MECH 455 Computer Integrated Manufacturing F | 3.5
- MECH 456 Introduction to Robotics F | 3.5
  OR
- ELEC 448 Introduction to Robotics: Mechanics and Control F | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 482 Noise Control W | 3.5
- MECH 492 Biological Fluid Dynamics F | 3.5
- MECH 494 Kinematics of Human Motion W | 3.5
- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5
- MECH 496 Musculoskeletal Biomechanics F | 3.5
- MECH 430 NOT OFFERED 2021-2022 - Thermal Systems Design W | 4
- MINE 472 Not Offered 2021-2022 Mining Systems, Automation, and Robotics O/L | K3.5

Mathematics and Engineering, Computing and Communications (M9): Technical Electives

List I:

(choose AT LEAST ONE course)

- MTHE 406 NOT OFFERED 2021-2022 - Introduction to Coding Theory F | 3
- MTHE 418 Number Theory and Cryptography W | 3
- MTHE 430 Modern Control Theory F | 4
- MTHE 434 Optimization Theory with Applications to Machine Learning W | 3.5
- MTHE 472 Control of Stochastic Systems W | 3
- MTHE 478 NOT OFFERED 2021-2022 - Topics in Communication Theory F/W | 3
- MTHE 484 NOT OFFERED 2021-2022 - Data Networks W | 3
- MTHE 454 NOT OFFERED 2021-2022 - Statistical Spectrum Estimation W | 3
- MTHE 437 Topics in Applied Mathematics W | 3.5

List II:

- CMPE 434 NOT OFFERED 2021-2022 Distributed Systems F | 3
- CMPE 454 Computer Graphics W | 3
- CMPE 457 Image Processing and Computer Vision F | 3

- ELEC 374 Digital Systems Engineering W | 4.25
- ELEC 377 Operating Systems F | 4
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 422 NOT OFFERED 2021-2022 Digital Signal Processing: Random Models and Applications F | 3.5
- ELEC 461 NOT OFFERED 2021-2022 Digital Communications F | 3.5
- ELEC 464 Wireless Communications F | 3
- ELEC 470 Computer System Architecture W | 3.5
- ELEC 373 Computer Networks W | 3.5
- SOFT 437 Performance Analysis W | 3
- CMPE 251 Data Analytics F | 3
- CMPE 351 Advanced Data Analytics W | 3

Mathematics and Engineering, Systems and Robotics (M11): Technical Electives

List I:

(choose AT LEAST ONE course)

- MTHE 406 NOT OFFERED 2021-2022 - Introduction to Coding Theory F | 3
- MTHE 434 Optimization Theory with Applications to Machine Learning W | 3.5
- MTHE 439 Lagrangian Mechanics, Dynamics, and Control W | 3.5
- MTHE 477 Data Compression and Source Coding W | 3
- MTHE 478 NOT OFFERED 2021-2022 - Topics in Communication Theory F/W | 3
- MTHE 484 NOT OFFERED 2021-2022 - Data Networks W | 3
- MTHE 454 NOT OFFERED 2021-2022 - Statistical Spectrum Estimation W | 3
- MTHE 455 Stochastic Processes and Applications F | 3.5
- MTHE 433 Continuum Mechanics with Applications W | 3
- MTHE 437 Topics in Applied Mathematics W | 3.5

List II:

- ELEC 353 Electronics II F | 4.25
- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 431 Power Electronics F | 3.25
- ELEC 448 Introduction to Robotics: Mechanics and Control F | 3.5
  OR
- MECH 456 Introduction to Robotics F | 3.5
- ELEC 454 NOT OFFERED 2021-2022 Analog Electronics W | 3.25
- ELEC 457 Integrated Circuits and System Applications W | 3.25
- ELEC 461 NOT OFFERED 2021-2022 Digital Communications F | 3.5
- ELEC 464 Wireless Communications F | 3
- ELEC 483 Microwave and RF Circuits and Systems W | 4.25
- ELEC 486 Fiber Optic Communications F | 3.75

- MECH 452 Mechatronics Engineering F | 5
- MINE 472 Not Offered 2021-2022 Mining Systems, Automation, and Robotics O/L | K3.5

Mechanical Engineering

Department Head: K. Pilkey

Chair of Undergraduate Studies: R. Sellens

Undergraduate Program Assistant: J. Brown and K. Iley
General Advisor Email: MME.Advisor@queensu.ca
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Fax: (613) 533-6489
Departmental Web Site: http://me.queensu.ca/

The second year curriculum is common to all sub-plans, but prior to or during the second year, students select from the following options (sub-plans) for their third year: General (ME1) allows students to select technical electives from a variety of specialized areas of study; Materials (ME2) includes courses in materials and metallurgical engineering; or Biomechanical (ME3) includes courses in the biomechanical field. Note that with the wide variety of courses offered, the Department cannot guarantee all courses are conflict free or offered each calendar year, particularly for students who choose to transfer or change options in their third or fourth year. Transferring programs could also result in extending the length of the program beyond the typical 4 years.

Students are invited to participate in one of the international design competition teams such as the Autonomous Sailboat Team (MAST), Baja SAE Team, Formula SAE Team, SAE Aero Design Team, ECO Vehicle Design Team, Fuel Cell Design Team or the Solar Design Team.

Options available:

- Materials Option
- Biomechanical Option

Mechanical and Materials Engineering, B.A.Sc. (Class of 2022)

Second Year CORE 2019/2020

- MECH 202 Mathematical and Computational Tools for Mechanical Engineers I F | K3.5
- MECH 213 NOT OFFERED 2021-2022 Manufacturing Methods F | 4.5

- MECH 217 Measurement in Mechatronics F | K 4.25
- MECH 221 Solid Mechanics I F, O/L | 4
- MECH 230 Applied Thermodynamics I F | 3.5
- MECH 270 Materials Science and Engineering F | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- MECH 203 Mathematical and Computational Tools for Mechanical Engineers II W | K3.5
- MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5
- MECH 228 Kinematics and Dynamics W | K3.5
- MECH 241 Fluid Mechanics I W/S/OL | 3.5
- MECH 273 Materials Science and Engineering Lab F/W | 1.0

Minimum Total Credits: 44.25

Note: Students should be aware that a transfer or a change in option choice may result in their program requirements taking more than the typical 4 years because of course availability and conflicts in their core timetable. The department cannot guarantee that courses will not conflict when a student changes options or transfers, especially after 2nd year.

MME students normally take APSC 200/293 in the winter term.

Third Year CORE 2020/2021

- MECH 302 Mathematical and Computational Tools for Mechanical Engineers III F | K3.5
- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MECH 323 Machine Design W | 4.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5

General Sub-Plan (ME1)

Note: MECH 396 and MECH 397 require MECH 370 and MECH 371 as co-requisites which would be additional courses in the third year for students in the ME1 or ME3 options.

- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

OR

- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 36

Materials Sub-Plan (ME2)

- MECH 370 Principles of Materials Processing F | 3.5
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Minimum Total Credits: 36

Biomechanical Sub-Plan (ME3)

Note: MECH 396 and MECH 397 require MECH 370 and MECH 371 as co-requisites which would be additional courses in the third year for students in the ME1 or ME3 options.

- MECH 393 Biomechanical Product Development W | 3.5
- MECH 394 Frontiers in Biomechanical Engineering F | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  OR
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 36

Fourth Year CORE 2021/2022

- Complementary Studies, List A, F, or W | 3
- Complementary Studies, List A or B, F or W | 6
- ME1 and ME2 Technical Electives (See Technical Elective List) F and W | 23.5
- ME3 Technical Electives (See Technical Elective List) F and W | 20.0

Important to Note: The above list is for a typical fourth year program and may vary depending on choices in previous years. Students must have a minimum total of 9 credits of Complementary Studies electives and a minimum of 23.5 credits of Technical Electives in the ME1 and ME2 options, and a minimum total of 20.0 credits of Technical Electives in the ME3 option, as detailed below. This count includes any electives taken in a student's 2nd, 3rd and 4th years from the specific lists required for their option which are outlined in the Technical Elective description.

General Sub-Plan (ME1)

- MECH 460 Team Project - Conceive and Design F | K4
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 38

Materials Sub-Plan (ME2)

- MECH 460 Team Project - Conceive and Design F | K4
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 38

Biomechanical Sub-Plan (ME3)

- MECH 460 Team Project - Conceive and Design F | K4
- MECH 464 Communications and Project Management F | 1.5
- MECH 462 Team Project - Implement and Operate W | K3.5

Minimum Total Credits: 38

All students must take a final year capstone design course in their program. For the ME1 and ME2 option students this course would normally be MECH 460 (4 credits, Fall) coupled with MECH 464 (1.5 credits, Fall). ME3 students will normally take MECH 460 (4 credits, Fall) coupled with MECH 464 (1.5 credits, Fall) in addition to MECH 462 (3.5 credits, Winter).

However, students in the ME1 and ME2 options may choose to take APSC 480 (9 credits, Fall and Winter), Multi-disciplinary Industry Engineering Design Project as a substitute for MECH 460 and MECH 464, and will receive 3.5 credits of List 1 technical electives that will count towards their required minimum technical elective credit count.

ME3 students may choose to take APSC 480 (9 credits, FW) as a substitute for MECH 460, MECH 464, and MECH 462.

Note that APSC 480 has a prerequisite of APSC 381 , normally taken in the winter term of third year.

Important Note: All students who want to take APSC 480 must make sure they DROP MMECH 460, MECH 464, and MECH 462 from their pre-loaded courses on SOLUS, and ADD APSC

480. All students are limited to taking only ONE final year capstone project course, either MECH 460 or APSC 480.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Mechanical Program, the Engineering Economics core course is APSC 221 , and the Communications core courses are APSC 293 and MECH 464 (or APSC 480).

Technical Electives

Students are required to complete technical electives dependent on their option, as listed below:

ME1 Option

A minimum of 17.0 credits from any combination of courses on Lists 1, 2 or 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2, 3 or 4

A minimum of 3.0 additional credits from ANY* Queen's undergraduate course

For a minimum total requirement of technical electives of 23.5 credits

*** Students who go away on QUIP and complete their internship requirements can use APSC 303 as an ANY course at Queen's or List B Complementary Study.**

ME2 Option

A minimum of 10.0 credits from courses on List 2

A minimum of 7.0 additional credits from any combination of courses on Lists 1, 2 or 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2, 3 or 4

A minimum of 3.0 additional credits from ANY* Queen's undergraduate course

For a minimum total requirement of technical electives of 23.5 credits

*** Students who go away on QUIP and complete their internship requirements can use APSC 303 as an ANY course at Queen's or List B Complementary Study.**

ME3 Option

A minimum of 10.0 credits from courses on List 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2 or 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2, 3 or 4

A minimum of 3.0 additional credits from ANY* Queen's undergraduate course

For a minimum total requirement of technical electives of 20.0 credits

*** Students who go away on QUIP and complete their internship requirements can use APSC 303 as an ANY course at Queen's or List B Complementary Study.**

(Note that ME3 students are required to take MECH 462 as core, but it is an optional List 1 technical elective for ME1 and ME2 students. Students take the same total load in all three options.)

(As an example, 17.5 from List 1, 2 or 3; 3.0 from List 4; 3.0 from ANY Queen's undergraduate course(s) would also satisfy the ME1 requirement.)

For all courses, students must meet the prerequisite requirements and no exclusion courses are allowed. Any exception to the requirements above must be approved by the Undergraduate Chair. It is the sole responsibility of the student to ensure that elective weights are sufficient to meet the total technical elective requirement.

All course availabilities and the term in which a course is held can change from one academic year to the next. This can occur due to curriculum changes, instructor availability or a change in departmental resources. Please refer to the individual course descriptions in the current calendar for further details.

Mechanical and Materials Engineering: Technical Elective Lists

Mechanical and Materials Engineering, B.A.Sc. (Class of 2023)

Second Year Common Core - 2020/2021

- MECH 202 Mathematical and Computational Tools for Mechanical Engineers I F | K3.5
- MECH 211 Manufacturing Methods F | 3.5
- MECH 212 Machine Tool Laboratory F/W | 1.0
- MECH 217 Measurement in Mechatronics F | K 4.25
- MECH 221 Solid Mechanics I F, O/L | 4
- MECH 230 Applied Thermodynamics I F | 3.5
- MECH 270 Materials Science and Engineering F | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- MECH 203 Mathematical and Computational Tools for Mechanical Engineers II W | K3.5
- MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5
- MECH 228 Kinematics and Dynamics W | K3.5

- MECH 241 Fluid Mechanics I W/S/OL | 3.5
- MECH 273 Materials Science and Engineering Lab F/W | 1.0

Minimum Total Credits: 44.25

Students take either MECH 211 and MECH 212, or MECH 213. MECH 213 combines the content of 211 and 212 in a single course.

Note: Students should be aware that a transfer or a change in option choice may result in their program requirements taking more than the typical 4 years because of course availability and conflicts in their core timetable. The department cannot guarantee that courses will not conflict when a student changes options or transfers, especially after 2nd year.

MME students normally take APSC 200/293 in the winter term.

Third Year Common Core - 2021/2022

- MECH 302 Mathematical and Computational Tools for Mechanical Engineers III F | K3.5
- MECH 310 Digital Systems for Mechatronics F | K4.5
- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MECH 323 Machine Design W | 4.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5

General Sub-Plan (ME1)

Note: MECH 396 and MECH 397 require MECH 370 and MECH 371 as co-requisites which would be additional courses in the third year for students in the ME1 or ME3 options.

- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  OR
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Materials Sub-Plan (ME2)

- MECH 370 Principles of Materials Processing F | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Biomechanical Sub-Plan (ME3)

Note: MECH 396 and MECH 397 require MECH 370 and MECH 371 as co-requisites which would be additional courses in the third year for students in the ME1 or ME3 options.

- MECH 393 Biomechanical Product Development W | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  OR
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 394 Frontiers in Biomechanical Engineering F | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  OR
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Fourth Year Common Core - 2022/2023

- Complementary Studies, List A, F or W | 3
- Complementary Studies, List A or B, F or W | 6
- ME1 and ME2 Technical Electives (See Technical Elective List) F and W | 20.5
- ME3 Technical Electives (See Technical Elective List) F and W | 17.0

Important to Note: The above list is for a typical fourth year program and may vary depending on choices in previous years. Students must have a minimum total of 9 credits of Complementary Studies electives and a minimum of 23.5 credits of Technical Electives in the ME1 and ME2 options, and a minimum of 20.0 credits of Technical Electives in the ME3 option, as detailed below. This count includes any electives taken in a student's 2nd, 3rd and 4th years from the specific lists required for their option which are outlined in the Technical Elective description.

General Sub-Plan (ME1) Core

- MECH 460 Team Project - Conceive and Design F | K4
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 35

Materials Sub-Plan (ME2) Core

- MECH 460 Team Project - Conceive and Design F | K4
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 35

Biomechanical Sub-Plan (ME3) Core

- MECH 460 Team Project - Conceive and Design F | K4
- MECH 464 Communications and Project Management F | 1.5
- MECH 462 Team Project - Implement and Operate W | K3.5

Minimum Total Credits: 35

All students must take a final year capstone design course in their program. For the ME1 and ME2 option students this course would normally be MECH 460 (4 credits, Fall) coupled with MECH 464 (1.5 credits, Fall). ME3 students will normally take MECH 460 (4 credits, Fall) coupled with MECH 464 (1.5 credits, Fall), in addition to MECH 462 (3.5 credits, Winter).

However, students in the ME1 and ME2 options may choose to take APSC 480 (9 credits, Fall and Winter), Multi-disciplinary Industry Engineering Design Project as a substitute for MECH 460 and MECH 464, and if the case will receive 3.5 credits of List 1 technical electives that will count towards their required minimum technical elective credit count.

ME3 students may choose to take APSC 480 (9 credits, FW) as a substitute for MECH 460, MECH 464, and MECH 462.

Important Note: All students who want to take APSC 480 must make sure they **DROP** MECH 460, MECH 464, and MECH 462 from their preloaded courses on SOLUS, and **ADD** APSC 480. All students are limited to taking only **ONE** final year capstone project course, either MECH 460 or APSC 480.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Mechanical Program, the Engineering Economics core course is APSC 221, and the Communications core courses are APSC 293 and MECH 464.

Technical Electives

Students are required to complete technical electives dependent on their option, as listed below:

ME1 Option

A minimum of 17.0 credits from any combination of courses on Lists 1, 2 or 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2, 3 or 4

For a minimum total requirement of technical electives of 20.5 credits

ME2 Option

A minimum of 10.0 credits from courses on List 2

A minimum of 7.0 additional credits from any combination of courses on Lists 1, 2 or 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2, 3 or 4

For a minimum total requirement of technical electives of 20.5 credits

ME3 Option

A minimum of 10.0 credits from courses on List 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2 or 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2, 3 or 4

For a minimum total requirement of technical electives of 17.0 credits

(Note that ME3 students are required to take MECH 462 as core, but it is an optional List 1 technical elective for ME1 and ME2 students. Students take the same total load in all three options.)

(As an example, 17.5 from List 1, 2 or 3; 3.0 from List 4 would also satisfy the ME1 requirement.)

For all courses, students must meet the prerequisite requirements and no exclusion courses are allowed. Any exception to the requirements above must be approved by the Undergraduate Chair. It is the sole responsibility of the student to ensure that elective weights are sufficient to meet the total technical elective requirement.

All course availabilities and the term in which a course is held can change from one academic year to the next. This can occur due to curriculum changes, instructor availability or a change in departmental resources. Please refer to the individual course descriptions in the current calendar for further details.

Mechanical and Materials Engineering: Technical Elective Lists

Mechanical and Materials Engineering, B.A.Sc. (Class of 2024)

Second Year Common Core- 2021-2022

- MECH 202 Mathematical and Computational Tools for Mechanical Engineers I F | K3.5
- MECH 211 Manufacturing Methods F | 3.5
- MECH 212 Machine Tool Laboratory F/W | 1.0
- MECH 213 NOT OFFERED 2021-2022 Manufacturing Methods F | 4.5
- MECH 217 Measurement in Mechatronics F | K 4.25
- MECH 221 Solid Mechanics I F, O/L | 4
- MECH 230 Applied Thermodynamics I F | 3.5
- MECH 270 Materials Science and Engineering F | 3.5
- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 293 Engineering Communications l F/W | K1
- MECH 203 Mathematical and Computational Tools for Mechanical Engineers II W | K3.5
- MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5
- MECH 228 Kinematics and Dynamics W | K3.5
- MECH 241 Fluid Mechanics I W/S/OL | 3.5
- MECH 273 Materials Science and Engineering Lab F/W | 1.0

Minimum Total Credits: 44.25

Students take either MECH 211 and MECH 212, or MECH 213. MECH 213 combines the content of 211 and 212 in a single course.

Note: Students should be aware that a transfer or a change in option choice may result in their program requirements taking more than the typical 4 years because of course availability and conflicts in their core timetable. The department cannot guarantee that courses will not conflict when a student changes options or transfers, especially after 2nd year.

MME students normally take APSC 200/293 in the winter term.

Third Year Common Core- 2022-2023

- MECH 302 Mathematical and Computational Tools for Mechanical Engineers III F | K3.5
- MECH 310 Digital Systems for Mechatronics F | K4.5
- MECH 321 Solid Mechanics II F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MECH 323 Machine Design W | 4.5
- MECH 346 Heat Transfer W | 3.5
- MECH 350 Automatic Control W | 3.5

General Sub-Plan (ME1)

Note: MECH 396 and MECH 397 require MECH 370 and MECH 371 as co-requisites which would be additional courses in the third year for students in the ME1 or ME3 options.

- MECH 330 Applied Thermodynamics II F | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  or
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 341 Fluid Mechanics II W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  or
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Materials Sub-Plan (ME2)

- MECH 370 Principles of Materials Processing F | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Biomechanical Sub-Plan (ME3)

Note: MECH 396 and MECH 397 require MECH 370 and MECH 371 as co-requisites which would be additional courses in the third year for students in the ME1 or ME3 options.

- MECH 393 Biomechanical Product Development W | 3.5
- MECH 396 Mechanical and Materials Engineering Laboratory I F | K2
  or
- MECH 398 Mechanical Engineering Laboratory I F | K2
- MECH 394 Frontiers in Biomechanical Engineering F | 3.5
- MECH 397 Mechanical and Materials Engineering Laboratory II W | K2
  or
- MECH 399 Mechanical Engineering Laboratory II W | K2

Minimum Total Credits: 40.5

Fourth Year Common Core- 2023-2024

- Complementary Studies, List A, F or W | 3
- Complementary Studies, List A or B, F or W | 6
- ME1 and ME2 Technical Electives (See Technical Elective List) F and W | 20.5
- ME3 Technical Electives (See Technical Elective List) F and W | 17.0

Important to Note: The above list is for a typical fourth year program and may vary depending on choices in previous years. Students must have a minimum total of 9 credits of Complementary Studies electives and a minimum of 27 credits of Technical Electives in the ME1 and ME2 options, and a minimum total of 23. 5 credits of Technical Electives in the ME3 option, as detailed below. This count includes any electives taken in a student's 2nd, 3rd and 4th years from the specific lists required for their option which are outlined in the Technical Elective description.

General Sub-Plan (ME1) Core

- MECH 460 Team Project - Conceive and Design F | K4
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 35

Materials Sub-Plan (ME2) Core

- MECH 460 Team Project - Conceive and Design F | K4
- MECH 464 Communications and Project Management F | 1.5

Minimum Total Credits: 35

Biomechanical Sub-Plan (ME3) Core

- MECH 460 Team Project - Conceive and Design F | K4
- MECH 464 Communications and Project Management F | 1.5
- MECH 462 Team Project - Implement and Operate W | K3.5

Minimum Total Credits: 38

All students must take a final year capstone design course in their program. For the ME1 and ME2 option students this course would normally be MECH 460 (4 credits, Fall) coupled with MECH 464 (1.5 credits, Fall). ME3 students will normally take MECH 460 (4 credits, Fall) coupled with MECH 464 (1.5 credits, Fall) in addition to MECH 462 (3.5 credits, Winter).

However, students in the ME1 and ME2 options may choose to take APSC 480 (9 credits, Fall and Winter), Multi-disciplinary Industry Engineering Design Project as a substitute for MECH 460 and MECH 464, and will receive 3.5 credits of List 1 technical electives that will count towards their required minimum technical elective credit count.

ME3 students may choose to take APSC 480 (9 credits, FW) as a substitute for MECH 460, MECH 464, and MECH 462.

Important Note: All students who want to take APSC 480 must make sure they **DROP** MECH 460, MECH 464, and MECH 462 from their pre-loaded courses on SOLUS, and **ADD** APSC 480. All students are limited to taking only **ONE** final year capstone project course, either MECH 460 or APSC 480.

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering plans. For the Mechanical Program, the Engineering Economics core course is APSC 221, and the Communications core courses are APSC 293 and MECH 464.

Technical Electives

Students are required to complete technical electives dependent on their option, as listed below:

ME1 Option

A minimum of 17.0 credits from any combination of courses on Lists 1, 2 or 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2, 3 or 4

For a minimum total requirement of technical electives of 20.5 credits

ME2 Option

A minimum of 10.0 credits from courses on List 2

A minimum of 7.0 additional credits from any combination of courses on Lists 1, 2 or 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2, 3 or 4

For a minimum total requirement of technical electives of 23.5 credits

ME3 Option

A minimum of 10.0 credits from courses on List 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2 or 3

A minimum of 3.5 additional credits from any combination of courses on Lists 1, 2, 3 or 4

For a minimum total requirement of technical electives of 17.0 credits

(Note that ME3 students are required to take MECH 462 as core, but it is an optional List 1 technical elective for ME1 and ME2 students. Students take the same total load in all three options.)

(As an example, 17.5 from List 1, 2 or 3; 3.0 from List 4 would also satisfy the ME1 requirement.)

For all courses, students must meet the prerequisite requirements and no exclusion courses are allowed. Any exception to the requirements above must be approved by the Undergraduate Chair. It is the sole responsibility of the student to ensure that elective weights are sufficient to meet the total technical elective requirement.

All course availabilities and the term in which a course is held can change from one academic year to the next. This can occur due to curriculum changes, instructor availability or a change in departmental resources. Please refer to the individual course descriptions in the current calendar for further details.

Mechanical and Materials Engineering: Technical Elective Lists

Mechanical and Materials Engineering: Technical Electives

These lists establish which courses qualify to meet the program elective requirements for each of the academic plans.

List 1: General Mechanical Engineering Electives

These courses provide experiences that are central to the development of General Mechanical Engineering attributes. Lists 1A and 1B are included in List 1 for meeting technical elective requirements.

- APSC 381 Advanced Design and Skills for Innovation W | K3.5
- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7

- APSC 401 Interdisciplinary Projects W | K4.5
- CHEE 400 DELETED Technology, Engineering & Management (TEAM) FW | K7
- CHEE 490 Polymer Formulations and Processing Technology W | 3.5
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 333 Electric Machines W | 4.25
- MECH 330 Applied Thermodynamics II F | 3.5 (Option core to ME1, and a List 1 Tech for ME2 and ME3)
- MECH 341 Fluid Mechanics II W | 3.5 (Option core to ME1, and a List 1 Tech for ME2 and ME3)
- MECH 361 NOT OFFERED 2021-2022 - Project Based Engineering: Conceive, Design, Implement and Operate W | K3.5
- MECH 370 Principles of Materials Processing F | 3.5 (Option core to ME2, and List 1 to ME1 and ME3)
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5 (Option core to ME2, and List 1 to ME1 and ME3)
- MECH 393 Biomechanical Product Development W | 3.5 (Option core to ME3, and a List 1 Tech for ME1 and ME2)
- MECH 394 Frontiers in Biomechanical Engineering F | 3.5 (Option core to ME3, and a List 1 Tech for ME1 and ME2)
- MECH 420 NOT OFFERED 2021-2022 - Vibrations W | 3.5
- MECH 423 Introduction to Microsystems W | 3.5
- MECH 424 NOT OFFERED 2021-2022 - Sustainable Product Design F | 3.5
- MECH 430 NOT OFFERED 2021-2022 - Thermal Systems Design W | 4
- MECH 435 Internal Combustion Engines F | 3.5
- MECH 437 Fuel Cell Technology F | 3.5
- MECH 439 Turbomachinery W | 3.5
- MECH 441 NOT OFFERED 2021-2022 - Fluid Mechanics III W | 3.5
- MECH 444 NOT OFFERED 2021-2022 - Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow W | 3.5
- MECH 452 Mechatronics Engineering F | 5
- MECH 455 Computer Integrated Manufacturing F | 3.5
- MECH 456 Introduction to Robotics F | 3.5
- MECH 457 Additive Manufacturing W | 4
- MECH 461 Research Project W | K4
- MECH 462 Team Project - Implement and Operate W | K3.5 (Option core to ME3, and a List 1 Tech for ME1 and ME2)
- MECH 465 Computer-Aided Design F | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 481 NOT OFFERED 2021-2022 - Wind Energy F | 3.5
- MECH 482 Noise Control W | 3.5

List 1A: Engineering Science

These List 1 courses include substantial Engineering Science content and are staffed by Mechanical and Materials Engineering with licensed Professional Engineers, or EITs, as instructors to meet the requirements of CEAB Appendix 3.

- MECH 492 Biological Fluid Dynamics F | 3.5

List 1B: Engineering Design

These List 1 courses include substantial Engineering Design content and are staffed by Mechanical and Materials Engineering with licensed Professional Engineers as instructors to meet the requirements of CEAB Appendix 3.

- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5

List 2: Materials Engineering Electives

- MECH 461 Research Project W | K4
- MECH 470 Deformation Processing W | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 479 Nano-Structured Materials F | 3.5
- MECH 483 Nuclear Materials F | 3.5
- MECH 484 DELETED - Introduction to Ceramics F | 3.5

List 3: Biomechanical Engineering Electives

- MECH 461 Research Project W | K4
- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 440 Pharmaceutical Technology W | 3.5
- CHEE 450 DELETED - Engineering Biology W | 3.5
- CHEE 484 NOT OFFERED 2021-2022 Bioremediation W | 3.5
- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- MECH 465 Computer-Aided Design F | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 492 Biological Fluid Dynamics F | 3.5
- MECH 494 Kinematics of Human Motion W | 3.5
- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5

- MECH 496 Musculoskeletal Biomechanics F | 3.5

List 4: Multi-Disciplinary Engineering Electives

- ANAT 100 Anatomy of the Human Body F,W,S | 3.0
- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- CHEE 340 Biomedical Engineering W | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5
- CHEE 370 Deleted - Waste Treatment Processes W | 3.5
- CHEE 371 Mitigation of Industrial Pollution W | 3.5
- CHEE 412 Transport Phenomena W | 3.5
- CHEE 363 Electrochemical Engineering* W | 3.5
- CIVL 371 Groundwater Engineering F | 3.75
- CIVL 372 Water and Wastewater Engineering W | 4
- CIVL 471 Subsurface Contamination F | 4
- CIVL 473 Water Resources System W | 3.75
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- MTHE 212 Linear Algebra W | 3.5
- MTHE 337 Introduction to Operations Research Models W | 3
- MTHE 338 NOT OFFERED 2021-2022 - Fourier Methods for Boundary Value Problems F | 3.5
- MTHE 434 Optimization Theory with Applications to Machine Learning W | 3.5
- MTHE 472 Control of Stochastic Systems W | 3
- MINE 431 Life-Cycle Assessment for Green Technologies F | 3.5
- MINE 459 Risk and Reliability Analysis for Industrial Asset Management, Health & Safety F | 4
- ENPH 491 NOT OFFERED 2021-2022 Physics of Nuclear Reactors F | 3.5

Areas of Concentration in Mechanical

Although there is no formal streaming of electives in the Mechanical Engineering Curriculum, the following groupings are provided in order to give students some guidance in areas where they may wish to concentrate their studies.

Aerospace Engineering

- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5 (Core for ME2 option)
- MECH 437 Fuel Cell Technology F | 3.5
- MECH 439 Turbomachinery W | 3.5
- MECH 441 NOT OFFERED 2021-2022 - Fluid Mechanics III W | 3.5
- MECH 444 NOT OFFERED 2021-2022 - Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow W | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 481 NOT OFFERED 2021-2022 - Wind Energy F | 3.5

Biomechanical Engineering

- CHEE 340 Biomedical Engineering W | 3.5
- CHEE 450 DELETED - Engineering Biology W | 3.5
- MECH 370 Principles of Materials Processing F | 3.5 (Core for ME2 option)
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5 (Core for ME2 option)
- MECH 393 Biomechanical Product Development W | 3.5 (Core for ME3 option)
- MECH 394 Frontiers in Biomechanical Engineering F | 3.5 (Core for ME3 option)
- MECH 465 Computer-Aided Design F | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 492 Biological Fluid Dynamics F | 3.5
- MECH 494 Kinematics of Human Motion W | 3.5
- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5
- MECH 496 Musculoskeletal Biomechanics F | 3.5

Manufacturing Engineering

- APSC 381 Advanced Design and Skills for Innovation W | K3.5
- CHEE 400 DELETED Technology, Engineering & Management (TEAM) FW | K7
- MECH 370 Principles of Materials Processing F | 3.5 (Core for ME2 option)
- MECH 424 NOT OFFERED 2021-2022 - Sustainable Product Design F | 3.5
- MECH 455 Computer Integrated Manufacturing F | 3.5
- MECH 457 Additive Manufacturing W | 4
- MECH 462 Team Project - Implement and Operate W | K3.5 (Core for ME3 option)
- MECH 465 Computer-Aided Design F | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5
- MECH 482 Noise Control W | 3.5

Mechatronics Engineering

- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- MECH 420 NOT OFFERED 2021-2022 - Vibrations W | 3.5
- MECH 423 Introduction to Microsystems W | 3.5
- MECH 452 Mechatronics Engineering F | 5
- MECH 455 Computer Integrated Manufacturing F | 3.5
- MECH 456 Introduction to Robotics F | 3.5
- MECH 482 Noise Control W | 3.5

Energy and Fluid Systems

- MECH 430 NOT OFFERED 2021-2022 - Thermal Systems Design W | 4
- MECH 435 Internal Combustion Engines F | 3.5
- MECH 437 Fuel Cell Technology F | 3.5
- MECH 439 Turbomachinery W | 3.5
- MECH 441 NOT OFFERED 2021-2022 - Fluid Mechanics III W | 3.5
- MECH 444 NOT OFFERED 2021-2022 - Computational Fluid Dynamics W | 3.5
- MECH 448 Compressible Fluid Flow W | 3.5
- MECH 480 Airplane Aerodynamics and Performance W | 3.5
- MECH 481 NOT OFFERED 2021-2022 - Wind Energy F | 3.5
- MECH 492 Biological Fluid Dynamics F | 3.5

Materials Engineering

- MECH 370 Principles of Materials Processing F | 3.5 (Core to ME2 option)
- MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5 (Core to ME2 option)
- MECH 470 Deformation Processing W | 3.5
- MECH 476 Engineering of Polymers and Composite Materials W | 3.5
- MECH 478 Biomaterials F | 3.5
- MECH 479 Nano-Structured Materials F | 3.5
- MECH 483 Nuclear Materials F | 3.5
- MECH 484 DELETED - Introduction to Ceramics F | 3.5

Mechatronics and Robotics Engineering

Mechatronics and Robotics Engineering (MRE) program addresses the emerging disciplines of mechatronics and robotics engineering, and integrates the traditional disciplines of computer, electrical, and mechanical engineering, with key elements of automatic control, mechanics, electronics, intelligent systems, signal processing and telecommunications systems. This multidisciplinary approach recognizes the ever-increasing complexity of engineering systems, and the societal need for skilled engineers. The MRE program addresses the need for a truly integrated approach to mechatronics and robotics across four years of study. A sequence of experiential project-based design courses will progressively build the students' foundational knowledge and culminate in a capstone design project that could lead to participation in an external design competition. Following a common two years of study (with the first year being direct-entry from high-school), in their third year students can pursue either an electrical or a mechanical stream. In their final year, students will select eight technical electives, with the option of completing one of four recommended concentrations: automation, robotics, biomedical and intelligent systems. This will give them the opportunity to tailor the curriculum to their own interests.

Mechatronics & Robotics Engineering, B.A.Sc. (Class of 2025)

The Mechatronics and Robotics Engineering (MRE) program addresses the emerging disciplines of mechatronics and robotics engineering, and integrates the traditional disciplines of computer, electrical, and mechanical engineering, with key elements of automatic control, mechanics, electronics, intelligent systems, signal processing and telecommunications systems. This multidisciplinary approach recognizes the ever-increasing complexity of engineering systems, and the societal need for skilled engineers. The MRE program addresses the need for a truly integrated approach to mechatronics and robotics across four years of study. A sequence of experiential project-based design courses will progressively build the students' foundational knowledge and culminate in a capstone design project that could lead to participation in an external design competition. Following a common two years of study (with the first year being direct-entry from high-school), in their third year students can pursue either an electrical or a mechanical stream. In their final year, students will select eight technical electives, with the option of completing one of four recommended concentrations: automation, robotics, biomedical and intelligent systems. This will give them the opportunity to tailor the curriculum to their own interests.

First Year 2021-2022

- MREN 103 Mechatronics Design I W | 4
- MREN 178 Data Structures and Algorithms W | 4
- APSC 101 Engineering Problem Solving and Modeling F | K2.9
- APSC 102 Experimentation and Design F/W | K2.8
- APSC 111 Physics I F | 3.3
- APSC 112 Physics II W | 3.3
- APSC 131 Chemistry and Materials F | 3.3
- APSC 143 Introduction to Computer Programming for Engineers F | 3.3
- APSC 162 Engineering Graphics W | 2.5
- APSC 171 Calculus I F | 3.3
- APSC 172 Calculus II W | 3.3

- APSC 174 Introduction to Linear Algebra W, S | 3.3
- APSC 182 Applied Engineering Mechanics W, F, S | 1.7
- APSC 199 English Proficiency for Engineers FW, S | K0.2

Minimum Total Credits: 33.1

Second Year 2022-2023

- MREN 203 Mechatronics Design II W | 4
- MREN 223 Signals and Systems W | 5
- MREN 230 Thermodynamics and Heat Transfer F | 3.75
- MREN 241 Fluid Mechanics and Fluid Power W | 3.75
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- MECH 228 Kinematics and Dynamics W | K3.5
- MTHE 228 Complex Analysis W | 3.5
- MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5

Minimum Total Credits: 46.5

Third Year 2023-2024

- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MREN 303 Mechatronics Design III W | 4
- MREN 318 Sensors and Electric Actuators F | 5.5
- MREN 320 Automation: Machine Design and Control W | 3.5
- MREN 348 Introduction to Robotics W | 3.5
- ELEC 326 Probability and Random Processes F | 3.5
- ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4
- ELEC 372 Numerical Methods and Optimization W | 3.5
  Plus choose one (1) Complementary Studies course.
- ELEC 373 Computer Networks W | 3.5
- MECH 350 Automatic Control W | 3.5
- ELEC 353 Electronics II F | 4.25

Minimum Total Credits: 46 or 45.25

Fourth Year 2024-2025

- MREN 403 Mechatronics Design IV FW | 8
- MREN 410 Intelligent Machines and Autonomous Systems F | 3.5
- Two Complementary Studies (term dictated by timetable)
- Three Free Technical Electives (any course from FEAS calendar, timetable permitting)
- Five Primary Technical Electives (recommended Concentrations below, timetabling guaranteed)

Automation

- ELEC 431 Power Electronics F | 3.25
- ELEC 436 NOT OFFERED 2021-22 Electric Machines and Control W | 3
- ELEC 474 Machine Vision F | 3.5
- MECH 423 Introduction to Microsystems W | 3.5
- MECH 455 Computer Integrated Manufacturing F | 3.5

Minimum Total Credits: 43.25

Robotics

- ELEC 436 NOT OFFERED 2021-22 Electric Machines and Control W | 3
- ELEC 444 NOT OFFERED 2021-2022 Modeling and Computer Control of Mechatronic Systems W | 3.25
- ELEC 472 Artificial Intelligence W | 3.5
- ELEC 474 Machine Vision F | 3.5
- MECH 455 Computer Integrated Manufacturing F | 3.5

Minimum Total Credits: 39.75

Biomedical

- ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3
- MECH 393 Biomechanical Product Development W | 3.5
- MECH 394 Frontiers in Biomechanical Engineering F | 3.5
- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5
- MECH 496 Musculoskeletal Biomechanics F | 3.5

Minimum Total Credits: 43.5

Intelligent Systems

- ELEC 421 Digital Signal Processing: Filters and System Design F | 4
- ELEC 425 Machine Learning and Deep Learning F | 3.5

- ELEC 472 Artificial Intelligence W | 3.5
- ELEC 474 Machine Vision F | 3.5
- CMPE 325 Human-Computer Interaction W | 3

Mining Engineering

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The mineral industry deals with the excavation and processing of ore to obtain the mineral products required by contemporary society. To meet industrial requirements, the curriculum of Mining Engineering provides three closely associated options: Mining Engineering, Mineral Processing and Environmental Engineering and Mine-Mechanical Engineering**.** The Mining Engineering Option, in addition to the fundamentals of mining, includes elements of earthworks and excavation for both surface and underground. In the Mineral Processing and Environmental Engineering option, the subjects addressed include the design, operation and control of ore treatment plants and the environmental control systems required by government regulations. The Mine-Mechanical option produces mining engineers who understand the design, modification, automation, use and maintenance of heavy and specialized equipment in the mining industry.

Options available:

- Mining Option
- Mineral Processing Option
- Mechanical Option

Mining Engineering, B.A.Sc. (Class of 2022)

Second Year Common Core - 2019/2020

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- APSC 293 Engineering Communications l F/W | K1
- CIVL 222 Numerical Methods for Civil Engineers W | 5

- CIVL 230 Solid Mechanics I F | 4.25
- MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5
- MINE 201 Introduction to Mining and Mineral Processing F | 4
- MINE 202 DELETED - Computer Applications and Instrumentation in Mining F | 1.5
- MINE 225 Applied Rock Mechanics (only offered in 2018-2019 & 2019-2020, same course as MINE 325) W | 4.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5

Subtotal Credits: 35.25

Mining Option N1

- CHEE 209 Analysis of Process Data F | 3.5
  Complementary Studies, List A F | 3
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- MINE 267 Applied Chemistry for Mining W | 3.5
- MINE 268 Analytical Methods in Mining W | 1

Subtotal Credit: 14.5

Minimum Total Credits: 49.75

Minerals Processing Environmental Option N2

- CHEE 209 Analysis of Process Data F | 3.5
  Complementary Studies, List A F | 3
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- MINE 267 Applied Chemistry for Mining W | 3.5
- MINE 268 Analytical Methods in Mining W | 1

Subtotal Credits: 14.5

Minimum Total Credits: 49.75

Mine-Mechanical Option N3

- CHEE 209 Analysis of Process Data F | 3.5
  Complementary Studies, List A F | 3
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- MECH 228 Kinematics and Dynamics W | K3.5

Subtotal Credits: 13.5

Minimum Total Credits: 48.75

Third Year Common Core - 2020/2021

- MINE 321 Drilling and Blasting F | 4.5
- MINE 326 Operations Research F | 4.5
- MINE 330 Mineral Industry Economics F | 3.5
- MINE 331 Methods of Mineral Separation F | 4.5
- GEOE 262 Geological Aspects of Mineral Deposits W | 3.75
- MINE 324 Hydraulics for Mining Applications W | 3.5
- MINE 341 Open Pit Mining W | 4.5
- MINE 344 Underground Mining W | 4

Subtotal Credits: 31.75

Mining Option N1

- MINE 339 Mine Ventilation F | 4.5
- Mining Elective List A F | 3
- Mining Elective List A or B W | 3

Subtotal Credits: 10.5

Minimum Total Credits: 42.25

Minerals Processing Environmental Option N2

- CHEE 321 Chemical Reaction Engineering F | 3.5
- Mining Elective List A F | 3
- CHEE 319 Process Dynamics and Control W | 3.5

Subtotal Credits: 10

Minimum Total Credits: 41.75

Mine-Mechanical Option N3

- MECH 270 Materials Science and Engineering F | 3.5
- MECH 328 Dynamics and Vibration F | 3.5
- MECH 323 Machine Design W | 4.5
- MECH 350 Automatic Control W | 3.5

Subtotal Credit: 15

Minimum Total Credits: 46.75

Fourth Year Common Core - 2021/2022

- MINE 422 Mining and Sustainability F | 4
- MINE 431 Life-Cycle Assessment for Green Technologies F | 3.5
- MINE 459 Risk and Reliability Analysis for Industrial Asset Management, Health & Safety F | 4
- Complementary Studies List A or B W | 3
- Mining Elective List A or B   W | 3
- MINE 272 Applied Data Science W | 4.5

Subtotal Credit: 19

Mining Option N1

- MINE 467 Geostatistics and Orebody Modelling F | 4.5
- Mining Elective List A F | 3
- MINE 445 Open Pit Mine Design W | 5.5
- MINE 448 Underground Design W | 5.5

Subtotal Credits: 18.5

Minimum Total Credits: 40.5

Minerals Processing Environmental Option N2

- MINE 451 Chemical Extraction of Metals F | 4
- MINE 455 Design, Analysis and Operation of Mineral Processes F | 4.5
- MINE 458 Process Investigations W | 4
- Mining Elective List A W | 3
- Mining Elective List A or B W | 3

Subtotal Credits: 17.5

Minimum Total Credits:39.5

Mine-Mechanical Option N3

- MINE 339 Mine Ventilation F | 4.5
- Mining Elective List A or B F | 3
- MINE 471 Mine-Mechanical Design Project W | 5.5
- Mining Elective List A W | 3
- Mining Elective List A W | 3

Subtotal Credits: 22

Minimum Total Credits: 41

Elective Requirements

Students in all options (N1-Mine-Mine, N2-Mineral Processing Environmental, N3-Mine-Mechanical) must take a minimum of four courses from the approved Elective lists.

Mining Engineering: Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mining Program, the Engineering Economics courses are APSC 221 and MINE 330. The Communications course is APSC 293. Included in the core Mining program is an additional 2.0 credits of Linkage in MINE 459. In addition to this core content, Mining students must take at least 6 additional credits of Complementary Studies, of which at least 3 credits must be from List A and the remaining 3 credits can be from List A or B

Mining Engineering, B.A.Sc. (Class of 2023)

Second Year Common Core - 2020/2021

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- APSC 293 Engineering Communications l F/W | K1
- CIVL 230 Solid Mechanics I F | 4.25
- MINE 201 Introduction to Mining and Mineral Processing F | 4
- CHEE 209 Analysis of Process Data F | 3.5
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CIVL 222 Numerical Methods for Civil Engineers W | 5
- MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5
- MINE 267 Applied Chemistry for Mining W | 3.5
- MINE 268 Analytical Methods in Mining W | 1
- MINE 272 Applied Data Science W | 4.5

Subtotal Credits: 45.25

Mining Option N1

- Complementary Studies, List A W | 3

Subtotal Credits: 3

Minimum Total Credits: 48.25

Minerals Processing Environmental Option N2

- Complementary Studies, List A W | 3

Subtotal Credits: 7.5

Minimum Total Credits: 48.25

Mine-Mechanical Option N3

- MECH 228 Kinematics and Dynamics W | K3.5

Subtotal Credits: 3.5

Minimum Total Credits: 48.75

Third Year Common Core - 2021-2022

- MINE 321 Drilling and Blasting F | 4.5
- MINE 325 Applied Rock Mechanics F | 4.5
- MINE 326 Operations Research F | 4.5
- MINE 330 Mineral Industry Economics F | 3.5
- MINE 331 Methods of Mineral Separation F | 4.5
- GEOE 262 Geological Aspects of Mineral Deposits W | 3.75
- MINE 324 Hydraulics for Mining Applications W | 3.5
- MINE 341 Open Pit Mining W | 4.5
- MINE 344 Underground Mining W | 4

Subtotal Credits: 36.25

Mining Option N1

- MINE 339 Mine Ventilation F | 4.5
- Mining Elective List A W | 3
- Mining Elective List A or B W | 3

Subtotal Credits: 10.5

Minimum Total Credits: 46.75

Minerals Processing Environmental Option N2

- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 319 Process Dynamics and Control W | 3.5
- Mining Elective List A W | 3

Subtotal Credits: 10

Minimum Total Credits: 46.25

Mine-Mechanical Option N3

- MECH 328 Dynamics and Vibration F | 3.5
- MECH 323 Machine Design W | 4.5
- MECH 350 Automatic Control W | 3.5

Subtotal Credits: 11.5

Minimum Total Credits: 47.75

Fourth Year Common Core - 2022/2023

- MINE 422 Mining and Sustainability F | 4
- MINE 431 Life-Cycle Assessment for Green Technologies F | 3.5
- Mining Elective List A or B   W | 3
- Complementary Studies List A or B   W | 3
- MINE 459 Risk and Reliability Analysis for Industrial Asset Management, Health & Safety F | 4

Subtotal Credits: 17.50

Mining Option N1

- MINE 467 Geostatistics and Orebody Modelling F | 4.5
- Mining Elective List A or B W | 3
- MINE 445 Open Pit Mine Design W | 5.5
- MINE 448 Underground Design W | 5.5

Subtotal Credits:18.50

Minimum Total Credits: 36

Minerals Processing Environmental Option N2

- MINE 451 Chemical Extraction of Metals F | 4
- MINE 455 Design, Analysis and Operation of Mineral Processes F | 4.5
- Mining Elective List A W|3
- MINE 458 Process Investigations W | 4
- Mining Elective List A or B W | 3

Subtotal Credits: 17.50

Minimum Total Credits:35

Mine-Mechanical Option N3

- MINE 339 Mine Ventilation F | 4.5
- MINE 471 Mine-Mechanical Design Project W | 5.5

- Complementary Studies, List A F | 3
- Mining Elective List A or B   F | 3
- Mining Elective List A W | 3
- Mining Elective List A or B W | 3

Subtotal Credits: 22

Minimum Total Credits: 39.5

Elective requirements

Students in all options (N1-Mine-Mine, N2-Mineral Processing Environmental, N3-Mine-Mechanical) must take a minimum of four courses from the approved Elective lists.

Mining Engineering: Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mining Program, the Engineering Economics courses are APSC 221 and MINE 330. The Communications course is APSC 293. Included in the core Mining program is an additional 2.0 credits of Linkage in MINE 459. In addition to this core content, Mining students must take at least 6 additional credits of Complementary Studies, of which at least 3 credits must be from List A and the remaining 3 credits can be from List A or B

Mining Engineering, B.A.Sc. (Class of 2024)

Second Year Common Core - 2021-2022

- APSC 200 Engineering Design and Practice II F/W | K4
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- APSC 293 Engineering Communications l F/W | K1
- CHEE 209 Analysis of Process Data F | 3.5
- CIVL 230 Solid Mechanics I F | 4.25
- MINE 201 Introduction to Mining and Mineral Processing F | 4
- MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5
- CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5
- CIVL 222 Numerical Methods for Civil Engineers W | 5
- MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5
- MINE 267 Applied Chemistry for Mining W | 3.5
- MINE 268 Analytical Methods in Mining W | 1
- MINE 272 Applied Data Science W | 4.5

Subtotal Credits: 45.25

Mining Option N1

- Complementary Studies, List A W | 3

Subtotal Credits: 3

Minimum Total Credits: 48.25

Minerals Processing Environmental Option N2

- Complementary Studies, List A W | 3

Subtotal Credits: 3

Minimum Total Credits: 48.25

Mine-Mechanical Option N3

- MECH 228 Kinematics and Dynamics W | K3.5

Subtotal Credits: 3.5

Minimum Total Credits: 48.75

Third Year Common Core - 2022-2023

- MINE 321 Drilling and Blasting F | 4.5
- MINE 325 Applied Rock Mechanics F | 4.5
- MINE 326 Operations Research F | 4.5
- MINE 330 Mineral Industry Economics F | 3.5
- MINE 331 Methods of Mineral Separation F | 4.5
- GEOE 262 Geological Aspects of Mineral Deposits W | 3.75
- MINE 324 Hydraulics for Mining Applications W | 3.5
- MINE 341 Open Pit Mining W | 4.5
- MINE 344 Underground Mining W | 4

Subtotal Credits: 36.25

Mining Option N1

- MINE 339 Mine Ventilation F | 4.5
- Elective W | 3
- Elective W | 3

Subtotal Credits: 10.5

Minimum Total Credits: 46.75

Minerals Processing Environmental Option N2

- CHEE 321 Chemical Reaction Engineering F | 3.5
- CHEE 319 Process Dynamics and Control W | 3.5
- Elective W | 3

Subtotal Credits: 10

Minimum Total Credits: 46.25

Mine-Mechanical Option N3

- MECH 328 Dynamics and Vibration F | 3.5
- MECH 323 Machine Design W | 4.5
- MECH 350 Automatic Control W | 3.5

Subtotal Credits: 11.5

Minimum Total Credits: 47.75

Fourth Year Common Core - 2023-2024

- MINE 422 Mining and Sustainability F | 4
- MINE 431 Life-Cycle Assessment for Green Technologies F | 3.5
  Elective W | 3
  Complementary Studies List A or B W | 3
- MINE 459 Risk and Reliability Analysis for Industrial Asset Management, Health & Safety F | 4

Subtotal Credits: 17.50

Mining Option N1

- MINE 467 Geostatistics and Orebody Modelling F | 4.5

- Elective F | 3
- MINE 445 Open Pit Mine Design W | 5.5
- MINE 448 Underground Design W | 5.5

Subtotal Credits: 17.5

Minimum Total Credits: 36

Minerals Processing Environmental Option N2

- MINE 451 Chemical Extraction of Metals F | 4
- MINE 455 Design, Analysis and Operation of Mineral Processes F | 4.5
- MINE 458 Process Investigations W | 4
- Elective W | 3
- Elective W | 3

Subtotal Credits: 17.5

Minimum Total Credits: 35

Mine-Mechanical Option N3

- MINE 339 Mine Ventilation F | 4.5
- Complementary Studies, List A F | 3
- Elective F | 3
- Elective W | 3
- Elective W | 3
- MINE 471 Mine-Mechanical Design Project W | 5.5

Subtotal Credits: 22

Minimum Total Credits: 39.50

Elective requirements

Students in all options (N1-Mine-Mine, N2-Mineral Processing Environmental, N3-Mine-Mechanical) must take a minimum of four courses from the approved Elective lists.

Mining Engineering: Electives

Complementary Studies

Refer to the Complementary Studies section of this calendar for details regarding the requirements for all Engineering programs. For the Mining Program, the Engineering Economics courses are APSC 221 and MINE 330. The Communications course is APSC 293. Included in the core Mining program is an additional 2.0 credits of Linkage in MINE 459. In addition to this core content, Mining students must take at least 6 additional credits of Complementary Studies, of which at least 3 credits must be from List A and the remaining 3 credits can be from List A or B

Mining Engineering: Electives

Elective Requirements

> Students in all three options (N1, N2, N3) must take a minimum of 12 credits of Elective courses from the approved Elective list.
>
> Of these 12 credits, at least 6 credits must be from the relevant Mining Electives List A (-N1, -N2, or –N3). The remaining credits can be from Mining Electives List B, or also from the relevant Mining Electives List A (-N1, -N2, or –N3).

Elective List

- Some of the courses listed in this table also appear on Complimentary Studies List "A". Please note that a course can only count as either an Elective or a Complementary Studies List A (not as both).
- Please note that it is the student's responsibility to check SOLUS to determine if a courses is being offered during a particular year and if it is, in which term it is being held. Course availability and the term in which it is held can change on a yearly basis.

Mining Electives List A - N1

- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- CHEE 319 Process Dynamics and Control W | 3.5
- MECH 350 Automatic Control W | 3.5
- MNTC P07 Surveying Principles O/L | 3
- MNTC 415 Metal Extraction Processes O/L | 4
- MNTC 418 Sustainability and the Environment O/L | 3
- MNTC 419 Mine Supervision and Project Management O/L | 3
- MNTC 423 Geomatics O/L | 3
- LAW 204 Corporate Law
- MINE 451 Chemical Extraction of Metals F | 4

Mining Electives List A - N2

- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- LAW 204 Corporate Law
- MNTC P07 Surveying Principles O/L | 3
- MNTC 311 Ore Body Modelling and Resource Estimation O/L | 4.5
- MNTC 316 Ventilation and Hydraulics O/L | 4
- MNTC 413 Surface Mine Planning O/L | 4
- MNTC 414 Underground Mine Planning O/L | 4
- MNTC 418 Sustainability and the Environment O/L | 3
- MNTC 419 Mine Supervision and Project Management O/L | 3
- MNTC 423 Geomatics O/L | 3

Mining Electives List A - N3

- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- LAW 204 Corporate Law
- MINE 451 Chemical Extraction of Metals F | 4
- MNTC P07 Surveying Principles O/L | 3
- MNTC 311 Ore Body Modelling and Resource Estimation O/L | 4.5
- MNTC 415 Metal Extraction Processes O/L | 4
- MNTC 418 Sustainability and the Environment O/L | 3
- MNTC 419 Mine Supervision and Project Management O/L | 3
- MNTC 423 Geomatics O/L | 3

Mining Electives List B

- MINE 300 series Any 3rd-year non-core mining course offered by the mining department
- MINE 400 series Any 4th-year non-core mining course offered by the mining department
- MINE 800 series Any graduate mining course offered by the mining department and with approval of the School of Graduate Studies
- Languages Any language course from List "A" and List "C" selections. Note: Student's language skills will be evaluated prior to the approval of any language course.
- APSC 250 Biology Through an Engineering Lens S/OL | K3.5
- APSC 303 Professional Internship | 3.5
- APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7
- APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9
- CHEE 302 Technical Entrepreneurship W/OL, F/OL | K3.5
- CHEE 310 Deleted-Engineering Innovation and Entrepreneurship F | 3.5
- CHEE 323 Industrial Catalysis W | 3.5
- CHEE 330 Heat and Mass Transfer F | 3.5
- CHEE 342 Environmental Biotechnology F | 3.5
- CHEE 363 Electrochemical Engineering* W | 3.5
- CHEE 371 Mitigation of Industrial Pollution W | 3.5

- CHEE 380 Biochemical Engineering F | 3.5
- CHEE 412 Transport Phenomena W | 3.5
- CHEE 414 Foundations of the Oil and Gas Industry W | K3.5
- CHEE 418 Strategies for Process Investigations F | 3.5
- CHEE 434 Process Control II W | 3.5
- CHEE 460 Applied Surface and Colloid Science F | 3.5
- CIVL 215 Materials for Civil Engineers W | 4.5
- CIVL 340 Geotechnical Engineering I F | 3.75
- CIVL 341 Geotechnical Engineering II W | 4
- CIVL 371 Groundwater Engineering F | 3.75
- CIVL 471 Subsurface Contamination F | 4
- COMM 200 Introduction to Business 3
- COMM 211 Introduction to Financial Accounting 3
- COMM 212 Introduction to Management Accounting 3
- COMM 221 Introduction to Finance 3
- COMM 231 Introduction to Marketing 3
- COMM 251 Organizational Behaviour 3
- COMM 305 Introduction to Entrepreneurship 3
- COMM 310 Environmental Accounting 3
- COMM 311 Financial Accounting Practices, Principles and Concepts 3
- COMM 322 Financial Management: Strategy 3
- COMM 323 Corporate Financial Planning 3
- COMM 324 Investment and Portfolio Management 3
- COMM 325 Financial Modelling 3
- COMM 328 International Finance 3
- COMM 351 Leadership 3
- COMM 353 Managing Across Cultures 3
- COMM 357 Interpersonal Skills for Managers 3
- COMM 359 Power and Organizational Politics 3
- COMM 375 International Business 3
- COMM 381 Business Law I 3
- COMM 382 Business Law II 3
- COMM 408 Sustainability Strategies and Practices 3
- COMM 409 Sustainability Measurement, Implementation and Evaluation 3
- COMM 495 Project Management 3
- ECON 110 Principles of Economics 6
- ECON 111 Introductory Microeconomics 3
- ECON 112 Introductory Macroeconomics 3
- ECON 239 Economic Development F | 3
- ECON 240 Canadian Tax Policy W | 3
- ECON 261 Canadian Labour Relations F | 3
- ECON 290 Environmental Economics and Assessment F | 3
- ELEC 221 Electric Circuits F | 4.25
- ELEC 252 Electronics I W | 4.25

- ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5
- ELEC 271 Digital Systems F | 4
- ELEC 274 Computer Architecture W | 4
- ELEC 278 Fundamentals of Information Structures F | 4
- ELEC 280 Fundamentals of Electromagnetics W | 3.75
- ELEC 333 Electric Machines W | 4.25
- ELEC 431 Power Electronics F | 3.25
- ENSC 201 Environmental Toxicology and Chemical Risks W
- ENSC 301 Environmental Assessment W
- ENSC 305 Social Environments W
- ENSC 321 Environmental Justice in Global Context F
- ENSC 390 Sustainability W
- GEOE 221 Geological Engineering Field Methods F | 5
- GEOE 249 Geophysical Characterization of the Earth W | 3.5
- GEOE 319 Applied Geophysics W | 4.5
- GEOE 333 Terrain Evaluation W | 4
- GEOE 365 Geochemical Characterization of the Earth F | 4
- GEOE 463 Spatial Information Management in the Geosciences F | 3.5
- GEOE 475 Exploration and Environmental Geochemistry F | 4.3
- GEOE 481 Structural Analysis Applied to Resource Deposits W | 3.5
- GPHY 242 Remote Sensing I: Image Interpretation and Measurement 3-0-0 3
- GPHY 243 Geographic Information Science 3-0-2 4
- GPHY 304 Arctic and Periglacial Environments W | 3
- GPHY 312 Watershed Hydrology 3-0-3 4.5
- GPHY 342 Remote Sensing II: Digital Image Processing 2-0-0 2
- GPHY 345 Spatial Analysis 2-2-0 4
- GPHY 346 Environmental Modeling 2-2-0 4
- GPHY 351 Aboriginal Geographies of Canada 3-0-0 3
- LAW 201 Introduction to Canadian Law
- LAW 207 International Law
- LAW 202 Aboriginal Law
- LAW 203 Workplace Law
- Law 206 Intellectual Property Law
- MECH 270 Materials Science and Engineering F | 3.5
- MECH 323 Machine Design W | 4.5
- MECH 370 Principles of Materials Processing F | 3.5
- MECH 435 Internal Combustion Engines F | 3.5
- MECH 456 Introduction to Robotics F | 3.5
- MECH 465 Computer-Aided Design F | 3.5
- MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5

Mining Engineering Technology, BTech

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The modern mining industry is concerned with the stewardship and recovery of the earth's mineral resources in an economic and sustainable manner, while also adhering to ethical and social values. Mining professionals have to be technically proficient, work safely, have business and management skills, recognize and mitigate negative environmental effects, understand the interests of local communities, and design for sustainability. The Bachelor of Mining Engineering Technology curriculum has been designed to provide technical, managerial, and sustainability skills, as well as develop an understanding of the business of mining in terms of economics, finance, and people. Recognizing that technical competence is key to the business of mining, these competencies will be emphasized by providing the necessary fundamental background in science and mathematics, and reinforced through a two-week hands-on field school placement, occurring in the summer of each year (one in Kingston, the other in Timmins), which will also serve to enhance the development of applied skills and theoretical concepts. Ultimately, the curriculum is designed to produce experienced mining professionals with technical hands-on communication and business skills, sensitive to the values of society, and with an ability to adapt to the future needs of the industry.

Progression:

- *All curriculum may be completed at either a full-time or part-time pace.*
- *Courses are group-paced, delivered asynchronously, and are 12 weeks in length.*
- *Upon enrolment, students must complete a customized bridge curriculum (offered via distance delivery), before progressing into Year 3 of the program.*
- *Years 3 and 4 will each contain 12 courses (also offered via distance delivery - pending curriculum committee approval).*
- *Upon completion of each year's curriculum, students will then be required to complete a two-week, laboratory intensive field placement, consisting of a series of labs based on the year's curriculum.*

Mining Engineering Technology, BTech

Bridge Curriculum

- MNTC P01 Engineering Mathematics O/L | 3
- MNTC P02 Mining Geology O/L | 3
- MNTC P03 Foundational Mathematics O/L | 3
- MNTC P04 Calculus O/L | 3
- MNTC P05 Foundational Physics O/L | 3
- MNTC P06 Foundational Chemistry O/L | 3
- MNTC P07 Surveying Principles O/L | 3

Third Year Curriculum

- APSC 199 English Proficiency for Engineers FW, S | K0.2
- APSC 221 Economics and Business Practices in Engineering F/W/S | 3
- MNTC 301 Technical Writing and Communication O/L | 3
- MNTC 302 Engineering Physics O/L | 3
- MNTC 303 Engineering Chemistry O/L | 3
- MNTC 304 Applied Metrology and Data Analysis O/L | 3
- MNTC 305 Introduction to Mining O/L | 4
- MNTC 306 Mineral Processing Unit Operations O/L | 3
- MNTC 307 Geomechanics and Ground Control O/L | 4
- MNTC 310 Mining and Society O/L | 3
- MNTC 313 Introduction to Programming O/L | 3
- MNTC 314 Drilling and Blasting O/L | 4
- MNTC 316 Ventilation and Hydraulics O/L | 4
- MNTC 399 Field School I (on site) S | 5

Fourth Year Curriculum

- MNTC 311 Ore Body Modelling and Resource Estimation O/L | 4.5
- LAW 204 Corporate Law
- MNTC 408 Mine Health and Safety O/L | 3
- MNTC 409 Mineral Economics O/L | 3.5
- MNTC 413 Surface Mine Planning O/L | 4
- MNTC 414 Underground Mine Planning O/L | 4
- MNTC 415 Metal Extraction Processes O/L | 4
- MNTC 418 Sustainability and the Environment O/L | 3
- MNTC 419 Mine Supervision and Project Management O/L | 3
- MNTC 420 Physical Asset Management O/L | 3
- MNTC 423 Geomatics O/L | 3
- MNTC 498 Capstone Project O/L | 3
- MNTC 499 Field School II (on site) S | 5

Complementary Studies

Complementary studies include humanities, social sciences, arts, management, engineering economics and communications that complement the technical content of the curriculum. While considerable latitude is provided in the choice of suitable content for the complementary studies component of the curriculum, some areas of study are essential in the education of an engineer. Accordingly, the curriculum must include studies in the following:

a. Subject matter that deals with the humanities and social sciences

b. Oral and written communications

c. Professionalism, ethics, equity and law

d. The impact of engineering on society

e. Health and safety

f. Sustainable development and environmental stewardship

g. Engineering economics and project management

Language instruction may be included within complementary studies provided it is not taken to fulfill an admission requirement.

In all academic plans in the Faculty students must complete courses in Complementary Studies amounting to at least 18.75 credits (corresponding to 225 AUs, which is the minimum CEAB requirement). Some of these credits are obtained in faculty-wide core courses, while others may be drawn from a list of elective courses. All of the academic plans in the Faculty have courses in Complementary Studies built into the CORE of the curriculum, and/or have portions of technical courses assigned to topics in Complementary Studies. The exact requirements vary from plan to plan, the details are provided in the curriculum for each Academic Plan.

The table below shows the credits available in the core courses (minimum number of total credits available: 11.17, see Table 1). The rest of the units must be drawn from Lists A and B of elective courses to fulfill the 18.75 credit requirement. Students must thus take a minimum of 3 credits in Humanities and Social Sciences from List A, and an additional 6 credits from List A or B.

The lists are updated each year, and a course qualifies as a Complementary Studies course only if it appears on the list for the Academic Session in which the course is taken.

Table 1: Complementary Studies content in FEAS programs

Area of Complementary Study	**Core APSC Courses**	**Credits in core APSC courses**	**Minimum credits in various academic plans[2]**
Humanities and Social Science (H&SS)	N/A	0	0

Engineering Economics	APSC 221[1]	3	0
Communications, Impact of engineering on Society, Professionalism	APSC 100, APSC 293, APSC 200, APSC 151, APSC 199	6.67	1.5
Total 11.17 Credits		**9.67**	**1.5**

[1]Note: At the end of each Academic Plan listing in the Calendar there is an explanation of which courses may be taken to meet the requirement for engineering economics.

[2]Note: At the end of each Academic Plan listing in the Calendar there is an explanation of which additional courses must be taken to meet the total credit requirement for Communications.

IMPORTANT: Note it is always the student's responsibility to check that they have the total required number of units.

These Complementary Studies requirements are effective starting the 2020-2021 academic year. For previous years' requirements, please refer to the respective calendar.

List A and B:

Students must take a minimum of 3 credits in Humanities and Social Sciences from List A, and an additional 6 credits from List A or B.

Courses in LIST A introduce students to subject matter that deals with central issues, methodologies, and thought processes of the humanities and social sciences.

NOTE: A course will be accepted as a Humanities and Social Sciences (H&SS) credit only if it appears on the list of approved H&SS courses for the Academic Session in which the course is taken.

List A

Courses in LIST A introduce students to subject matter that deals with central issues, methodologies, and thought processes of the humanities and social sciences.

NOTE: A course will be accepted as a Humanities and Social Sciences (H&SS) credit only if it appears on the list of approved H&SS courses for the Academic Session in which the course is taken.

Art History

ARTH Levels 1-3	ARTH 1XX-3XX (except ARTH 245, ARTH 380, ARTH 395)	

Bader International Study Centre courses (online)

BISC 100	Thinking Locally	3.00
BISC 101	Acting Globally	3.00

Classical Studies

CLST Levels 1-2	CLST 1XX-2XX	
CLST 321	World Of Late Antiquity	3.00
CLST 332	The Iron Age to the End of the Persian Wars	3.00
CLST 333	The Rise of the Athenian Empire to the End of the Peloponnesian War	3.00
CLST 334	Fourth Century Greece to the Death of Alexander	3.00
CLST 335	The Hellenistic Successor Kingdoms to the Death of Cleopatra	3.00
CLST 340	The Roman Republic	3.00
CLST 341	The Roman Empire	3.00
CLST 343	The Later Roman Empire	3.00

Commerce

COMM 251	Organizational Behaviour	3.00
COMM 651	Organizational Behaviour	3.00

Creative Writing

CWRI 295	Introduction to Creative Writing in Short Fiction & Poetry	3.00
CWRI 397	The Literary Screenplay	3.00

Developmental Studies

DEVS 100	Canada and the "Third World"	6.00

DEVS 220	Introduction to Indigenous Studies	3.00
DEVS 221	Topics in Indigenous Human Ecology	3.00
DEVS 230	The Global Political Economy of Development	3.00
DEVS 240	Culture and Development	3.00
DEVS 260	Globalization, Gender & Development	3.00
DEVS 280	Global Engagement	3.00
DEVS 352	Technology and Development	3.00

Drama

DRAM 100	Introduction to Theatre	6.00
DRAM 200	Theatre History & Literature I	6.00
DRAM 205	Theatricality and Mass Media	3.00
DRAM 211	Introduction to Theatre for Young Audiences	3.00
DRAM 220	Play Reading and Analysis	3.00
DRAM 236	Public Presentation	3.00
DRAM 251	Introduction to Playwriting	3.00
DRAM 273	Medieval Drama Performance	3.00
DRAM 300	Theatre History & Literature II	6.00
DRAM 301	Theories of the Theatre I	3.00
DRAM 303	Indigenous Playwrights	3.00
DRAM 306	Canadian Drama	3.00

Economics

ECON 110	Principles of Economics	6.00
ECON 111	Introductory Microeconomics	3.00
ECON 112	Introductory Macroeconomics	3.00
ECON Level 2	ECON 2XX (Except ECON 250, ECON 255)	

Employment Relations

EMPR Levels 1-2	EMPR 1XX-2XX	

English

ENGL 100	Introduction to Literary Study	6.00
ENGL 160	Modern Prose Fiction	6.00
ENGL 2XX	ENG 2XX	

Environmental Studies

ENSC 290	Introduction to Ecological Economics	3.00
ENSC 305	Social Environments	3.00
ENSC 310	Environmental Policy	3.00
ENSC 311	Applied Environmental Policy	3.00
ENSC 315	Global Food Security, Agriculture, and Environment	3.00
ENSC 321	Environmental Justice in Global Context	3.00
ENSC 420	Gender and Environments	3.00

Film

FILM 110	Film, Media and Screen Cultures	6.00
FILM 210	The Horror Film	3.00
FILM 214	Mobile Communications	3.00
FILM 215	Science Fiction Cinema	3.00
FILM 220	Disney Pixar DreamWorks	3.00
FILM 225	The Comedy Film	3.00
FILM 236	Media and Cultural Studies	3.00
FILM 240	Media & Popular Culture	3.00
FILM 260	Digital Media Theory and Practice	3.00

French

FREN 241	Histoire culturelle et littéraire de l'Ancien Régime	3.00
FREN 285	Cinéma et société: aspects culturels de la francophonie	3.00

FREN 3XX	FREN 3XX (Except FREN 320, 331, 353, 360, 393)	
Gender Studies		
GNDS	GNDS 1XX-3XX (Levels 1-3)	
Geography		
GPHY 203	Water Resources and Management	3.00
GPHY 204	Forests as a Global Resource	3.00
GPHY 227	Cities: Geography, Planning and Urban Life	3.00
GPHY 228	Geography of the Global Political Economy	3.00
GPHY 229	Place, Space, Culture and Social Life	3.00
GPHY 230	Introduction to Urban and Regional Planning	3.00
GPHY 250	The Geography of Canada	3.00
GPHY 254	The Caribbean in Globalizing World	3.00
GPHY 257	The Geography of Middle America	3.00
GPHY 258	The Geography of South America	3.00
GPHY 320	Energy and Society	3.00
GPHY 325	Maps and Society	3.00
GPHY 327	The Geographical Imagination	3.00
GPHY 330	Transportation Geography	3.00
GPHY 362	Human Migration	3.00
Health		
HLTH 101	Social Determinants of Health	3.00
HLTH 237	Introduction to the Study of Alcohol and Drug Problems	3.00
HLTH 305	Fundamentals of Health Policy	3.00
HLTH 332	Foundations for Understanding Disability: A Health Perspective	3.00
HLTH 350	Topics in Global Health	3.00

HLTH 403	Community Based Rehabilitation	3.00
HLTH 404	Global Studies of Social Inclusion, Community Participation and Mental Illness	3.00
Hebrew		
HEBR 292	Intermediate Biblical Hebrew	3.00
HEBR 393	Reading Modern Hebrew Literature	3.00
History		
HIST	HIST 1XX-2XX (Except HIST 257)	
German		
GRMN 308	German Culture through Stories- 18th & 19th Century	3.00
GRMN 309	Topics in Cultural History II	3.00
GRMN 311	Topics in Cultural History I	3.00
GRMN 312	Topics in Cultural History II	3.00
Innovation and Entrepreneurship		
ENIN 301	Creative Entrepreneurship	3.00
ENIN 340	Topics in Innovation and Entrepreneurship	3.00
Interdisciplinary Studies		
IDIS 199	The Science of Mental Health, Well-being, and Resiliency	3.00
IDIS 210	Arts in Society	3.00
IDIS 220	Hacking the Humanities: An Introduction to the Digital Humanities	3.00
IDIS 280	Interprofessional Approaches in Healthcare	3.00
IDIS 302	Race and Racism	3.00
IDIS 303	Mathematics and Poetry	3.00
IDIS 304	British Studies I	3.00
Indigenous Studies		

INDG 301	Indigenous Ways of Knowing	3.00
International Studies		
INTS 306	Culture, Identity and Self	3.00
INTS 307	Intercultural Relations	3.00
INTS 321	Urban Images: Race, Gender, Sexuality and the Imagined City	3.00
Jewish Studies		
JWST	JWST 301, 302	
Language, Literature and Cultures		
LLCU	All LLCU 1XX, 2XX, 3XX except 101, 102, 103, 104	
Law		
LAW 201	Introduction to Canadian Law	3.00
LAW 202	Aboriginal Law	3.00
LAW 203	Workplace Law	3.00
LAW 204	Corporate Law	3.00
LAW 205	Public & Constitutional Law	3.00
LAW 206	Intellectual Property	3.00
LAW 207	International Law	3.00
Liberal Arts		
LIBS 100	Origins and Practices of Liberal Arts	3.00
Linguistics		
LING 100	Introduction to Linguistics	6.00
LING 202	Canadian English	3.00
LING 205	Language and Power	3.00
LING 210	Language Acquisition and Learning	3.00
Music		

MUSC 102	Western Music: Napoleon to 9/11	3.00
MUSC 114	Introduction to Teaching Music to Children	3.00
MUSC 171	Social History of Popular Music	3.00
MUSC 210	Western Art Music: Crusades to Colonialism	3.00
MUSC 211	Western Art Music: Industrialization to the Internet	3.00
MUSC 240	Music of Video Games	3.00
MUSC 245	Topics in Music and Cultures	3.00
MUSC 286	Women, Gender and Music	3.00
MUSC 289	Global Musics	3.00
MUSC 393	Music and Digital Media	3.00
MUSC 490	Gender and Popular Music	3.00
MUSC 491	Music and Mass Media	3.00
Music Theatre		
MUTH 110	The Republic to Rationalism: History, Arts, and Performance l	3.00
MUTH 111	Listening to Revolutions: History, Arts, and Performance ll	3.00
MUTH 201	Sex and Violence in Performance	3.00
MUTH 240	Digital Disruption in the Creative and Performing Arts	3.00
MUTH 251	Issues in Music Theatre	3.00
Philosophy		
PHIL	Levels 1-2 Philosophy 1XX-2XX	
PHIL 257	Ethics	6.00
Politics		
POLS 101	Contemporary Issues in Politics	3.00
POLS 110	Introduction to Politics and Government	6.00
Political Science		

POLS 2XX	POLS 2XX	
Psychology		
PSYC 100	Principles of Psychology	6.00
PSYC 221	Cognitive Psychology	3.00
PSYC 241	Social Psychology	3.00
PSYC 251	Developmental Psychology	3.00
Religion Studies		
RELS	RELS Levels 1-3, RELS 1XX-3XX	
Sociology		
SOCY 122	Introduction to Sociology	6.00
SOCY	SOCY Levels 2-3, SOCY 2XX-3XX	

List B (Professional Issues, Performance Arts and Languages, Management, Business and Law Courses)

Anishinaabe		
ANSH 101	Beginning Anishinaabe Language and Culture I	3.00
ANSH 102	Beginning Anishinaabe Language and Culture Il	3.00
Engineering and Applied Science		
APSC 223	Global Project Management	3.00
APSC 303	Professional Internship (*Not applicable for CMPE/ELEC students)	3.50
CHEE 302	Technical Entrepreneurship	3.50
MECH 333	Gender, Engineering and Technology	3.00
MNTC 409	Mineral Economics	3.50
Arabic		

ARAB 100	Introductory Arabic (Modern Standard)	6.00
ARAB 200	Intermediate Modern Standard Arabic	6.00

Biology

BIOL 111	Ecology and the Environment	3.00

Chemical Engineering

CHEE 302	Technical Entrepreneurship	3.50

Chinese

CHIN 100	Introductory Mandarin Chinese I	6.00

Commerce

COMM 200	Business Fundamentals	3.00
COMM 201	Introduction to Business for Entrepreneurs	3.00
COMM 211	Financial Accounting	3.00
COMM 212	Management Accounting	3.00
COMM 221	Introduction To Finance	3.00
COMM 231	Fundamentals of Marketing	3.00
COMM 251	Organizational Behaviour	3.00
COMM 303	Business And Ethics	3.00
COMM 305	Introduction To Entrepreneurship	3.00
COMM 310	Environmental Accounting	3.00
COMM 311	Fin Acctng Pract Prin & Concep	3.00
COMM 312	Intermed Management Accounting	3.00
COMM 313	Financial Accounting II	3.00
COMM 322	Advanced Corporate Finance	3.00
COMM 323	Corporate Financial Planning	3.00
COMM 326	Private Equity	3.00
COMM 328	International Finance	3.00

COMM 329	Management Of Financial Institutions	3.00
COMM 351	Leadership	3.00
COMM 353	Managing Across Cultures	3.00
COMM 357	Interpersonal Skills For Managers	3.00
COMM 375	International Business and the Nonmarket Environment	3.00
COMM 381	Business Law I	3.00
COMM 382	Business Law II	3.00
COMM 408	Sustainability Strategies and Practices	3.00
Developmental Studies		
DEVS 353	Business and Global Development	3.00
Drama		
DRAM 239	Special Topics in Performance I	3.00
DRAM 241	Design and Theatre	3.00
Employment Relations		
EMPR 100	Introduction to Employment Relations	3.00
EMPR 200	Unions and Labour Relations	3.00
EMPR 210	Employment Law	3.00
EMPR 220	Conflict Management	3.00
EMPR 230	Human Resource Management	3.00
EMPR 240	Workplace Policies and Governance	3.00
EMPR 250	Managing Workplace Health, Safety, and Wellness	3.00
EMPR 320	Workplace Mediation and Alternative Dispute Resolution	3.00
EMPR 330	Strategic HR Management: Building High Performance Workplaces	3.00
EMPR 335	Managing Employee Attitudes for Organizational Success	3.00
EMPR 370	Human Resource Analytics	3.00

Environmental Studies

ENSC 103	Environment and Sustainability	3.00
ENSC 200	Environmental History	3.00
ENSC 201	Environmental Toxicology and Chemical Risks	3.00
ENSC 301	Environmental Assessment	3.00
ENSC 320	Wildlife Issues in a Changing World	3.00
ENSC 390	Sustainability	3.00

Fine Art

ARTF 100	Introductory Drawing	6.00
ARTF 101	Fundamentals of Drawing and Painting	3.00
ARTF 102	Fundamentals of Drawing and Sculpture	3.00
ARTF 125	Introduction to Studio Art in Printmaking	3.00
ARTF 127	Introductory Fine Art I	6.00
ARTF 128	Introductory Fine Art II	6.00
ARTF 260	Studies In Studio Practice	3.00
ARTF 275	Digital Media in Studio Practice	3.00
ARTF 227	Intermediate Fine Art I	6.00
ARTF 2XX		

French

FREN 106	Communication et culture I	3.00
FREN 107	Communication et culture II	3.00
FREN 111	Révision de la grammaire I	3.00
FREN 112	Révision de la grammaire II	3.00
FREN 118	Communication et Culture III	3.00
FREN 150	Français intermédiaire	6.00

FREN 219	Communication et Culture IV	3.00
FREN 225	French in the Professional Workplace	3.00
French Studies		
FRST 125	Basic Business French	3.00
Geography		
GPHY 101	Human Geography	3.00
GPHY 314	Climate Change	3.00
GPHY 319	Contemporary Energy Resources	3.00
Geology		
GEOL 290	Worldbuilding	3.00
German		
GRMN 101	Beginner's German I	3.00
GRMN 102	Beginner's German II	3.00
GRMN 201	Intermediate German I	3.00
GRMN 202	Intermediate German II	3.00
GRMN 203	German Conversation and Culture	3.00
Greek		
GREK 112	Introductory Greek	6.00
Hebrew		
HEBR 190	Introduction to Modern Hebrew	6.00
HEBR 192	Introductory Biblical Hebrew	3.00
HEBR 193	Classical Hebrew Fundamentals	3.00
HEBR 294	Intermediate Modern Hebrew I	3.00
HEBR 295	Intermediate Modern Hebrew II	3.00
HEBR 301	Topics in Hebrew	3.00

History

HIST 257	Environmental History	3.00

Inuktitut

INUK 101	Beginning Inuktitut Language & Culture l	3.00
INUK 102	Beginning Inuktitut Language and Culture ll	3.00

Italian

ITLN 111	Beginning Italian I	3.00
ITLN 112	Beginning Italian II	3.00
ITLN 204	Italiano Intermedio	3.00

Innovation and Entrepreneurship

ENIN 200	Foundations of Entrepreneurship	3.00
ENIN 204	Publicity and Media Relations	3.00
ENIN 205	Innovation for STEAM	3.00
ENIN 207	Envisioning Disruptive Technologies	3.00

Japanese

JAPN 100	Introductory Japanese I	6.00
JAPN 200	Introductory Japanese II	6.00

World Language Studies

LANG 2XX

Language, Literature and Cultures

LLCU 101	Beginning Indigenous Language and Culture I	3.00
LLCU 102	Beginning Indigenous Language and Culture II	3.00

Latin

LATN 110	Introductory Latin	6.00

Law (Can be used as List A or B)

LAW 201	Introduction to Canadian Law	3.00

LAW 202	Aboriginal Law	3.00
LAW 203	Workplace Law	3.00
LAW 204	Corporate Law	3.00
LAW 205	Public & Constitutional Law	3.00
LAW 206	Intellectual Property	3.00
LAW 207	International Law	3.00

Linguistics

LING 1XX-2XX

Mohawk

MOHK 101	Beginning Mohawk Language & Culture l	3.00
MOHK 102	Beginning Mohawk Language & Culture ll	3.00
MOHK 201	Intermediate Mohawk Language and Culture	3.00
MOHK 202	Oral Mohawk Language	3.00

Music

(Maximum of two) **MUSC 100/200/300/400**	Small Ensemble	1.50
MUSC 104	Music Fundamentals	3.00
(Maximum of two) **MUSC 112/212/312/412**	Medium Ensemble	1.50
MUSC 114	Introduction to Teaching Music to Children	3.00
(Maximum of two) **MUSC 115/215/315/415**	Large Ensemble	1.50
MUSC 121	Applied Study I to IV	6.00
MUSC 152	Introduction to Vocal Composition	3.00
MUSC 156	Introduction to Digital Audio recording Editing and Mixing	3.00

MUSC 171	Social History of Popular Music	3.00
MUSC 180	Vocal Techniques and Methods	3.00
MUSC 191	Theory and Analysis I	6.00
MUSC 221	Applied Study II	6.00
MUSC 224	Applied Music	6.00
MUSC 227	Ear Training and Sight Singing II	3.00
MUSC 229	Keyboard Lab	3.00
MUSC 280	Vocal Techniques & Methods II	3.00
MUSC 281	Woodwind Techniques and Methods II	3.00
MUSC 283	Brass Techniques and Methods	3.00
MUSC 285	String Techniques and Methods	3.00
MUSC 292	Theory and Analysis IIA	3.00
Music Theater		
MUTH 232	Opera	3.00
MUTH 240	Digital Disruption in the Creative and Performing Arts	3.00
MUTH 340	Arts Professionalism	3.00
Portuguese		
PORT 103	Beginning Portuguese and Culture l	3.00
PORT 104	Beginning Portuguese and Culture ll	3.00
Sociology		
SOCY 284	Sociology of Information and Communication Technology	3.00
SOCY 363	Science, Technology and Society	3.00
Spanish		
SPAN 304	Español para contextos profesionales II	3.00
SPAN 111	Beginning Spanish I	3.00

SPAN 112	Beginning Spanish II	3.00
SPAN 204	Español intermedio	3.00
SPAN 205	Español avanzado	3.00
SPAN 206	Spanish Conversation and Culture	3.00
SPAN 301	Gramática avanzada y composición I	3.00
SPAN 302	Gramática avanzada y composición II	3.00
SPAN 303	Español para contextos profesionales I	3.00
SPAN 401	Advanced Grammar Through Translation I	3.00
SPAN 402	Advanced Grammar Through Translation II	3.00

Urban Planning

SURP 853	Environmental Services	3.00

Courses of Instruction

Applied Science

APSC 100 Engineering Practice l FW | K9

Lecture: Yes
Lab: Yes
Tutorial: Yes
This course introduces fundamental professional engineering skills and provides an opportunity to apply engineering science and mathematics content in situations emulating professional practice. It consists of three modules: Module 1. Problem analysis and modeling; Module 2. Experimentation and measurement; Module 3: Engineering design. The course provides an introduction to personal learning styles, team dynamics, oral and written presentation skills, laboratory data collection, analysis and presentation, project management, information management, problem analysis and modeling, numeric computation, economics, design methodologies, and workplace safety.

Academic Units:
Mathematics 0
Natural Sciences 16
Complementary Studies 36

Engineering Science 24
Engineering Design 33

APSC 101 Engineering Problem Solving and Modeling F | K2.9

Lecture: Yes
Lab: No
Tutorial: Yes
This course provides an opportunity for students to develop complex problem solving and critical thinking skills and to apply engineering science knowledge in modeling physical systems through computational software. Examples and project topics are chosen to complement instruction in engineering science and mathematics courses. Ethical, economic, and social factors are considered in engineering problem solving. NOTE: This course covers the content and objectives of APSC 100 Module 1, and is available by permission only.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 0
Engineering Design 17

PREREQUISITE(S): Permission of the instructor or Associate Dean (Academic)
EXCLUSION(S): APSC 100

APSC 102 Experimentation and Design F/W | K2.8

Lecture: No
Lab: Yes
Tutorial: Yes
This course introduces concepts of planning and designing experiments determine or measure particular system characteristics. The course content includes error analysis, data analysis and representation in Excel, and the design of experimental investigation for simple systems. NOTE: This course covers the content and objectives of APSC 100 Module 2, and is available by permission only.

Academic Units:
Mathematics 0
Natural Sciences 16
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): Permission of the instructor or Associate Dean (Academic)
EXCLUSION(S): APSC 100

APSC 103 Engineering Design Project W | K3.3

Lecture: Yes
Lab: No
Tutorial: Yes
This is a client-based team design project which develops skills including design, project management, technical communications, and professionalism. Students work in teams to define problems, gather and identify appropriate information, work effectively with teammates, generate ideas, select ideas, and implement a solution to a presented problems from a client. NOTE: This course covers the content and objectives of APSC 100 Module 3, and is available by permission only.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 6
Engineering Design 16

PREREQUISITE(S): Permission of the instructor or Associate Dean (Academic)
EXCLUSION(S): APSC 100

APSC 111 Physics I F | 3.3

Lecture: 2.8
Lab: 0
Tutorial: 0.5
This course is an introduction to Newtonian mechanics in the context of engineering applications. Lecture topics are: vectors, motion of a particle, particle dynamics, work and energy, statics and dynamics of rigid bodies, conservation of energy, momentum, and collisions.

Academic Units:
Mathematics 0
Natural Sciences 40
Complementary Studies 0
Engineering Science 0
Engineering Design 0

APSC 112 Physics II W | 3.3

Lecture: 2.8
Lab: 0
Tutorial: 0.5
This course continues from APSC 111 to introduce electricity and further develop fundamental ideas of mechanics in the context of engineering applications. Lecture topics include: oscillations and waves, electric charge, electrical current and resistance, EMF, D.C. circuits and electrical measurements, electric field and potential, magnetic fields and their origin, and electromagnetic induction.

Academic Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 10
Engineering Design 0

PREREQUISITE(S): APSC 111 and APSC 171

APSC 114 Electricity and Magnetism W | 3.3

Lecture: 2.8
Lab: 0
Tutorial: 0.5
This course continues from APSC 111 to introduce electricity and further develope fundamental ideas of mechanics in the context of engineering applications. Leture topics include: oscillations and waves, electric charge, electrical current and sestance, EMF, D.C. circuits and electrical measurements, electric field and potential, magnetic fields and their origin, and electromagnetic induction.

Academic Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 10
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 171
EXCLUSION(S): APSC 112

APSC 131 Chemistry and Materials F | 3.3

Lecture: 2.8
Lab: 0
Tutorial: 0.5

This course provides an introduction to the chemistry of materials: thermochemistry, heat, work, internal energy, enthalpy and the first law of thermodynamics; gas laws in ideal and non-ideal systems; phase equilibria in one component systems; concepts of bonding in the classification of materials; the physical, electrical and mechanical properties of metals, polymers, semiconductors and ceramics; techniques of characterizing materials.

Academic Units:
Mathematics 0
Natural Sciences 40
Complementary Studies 0
Engineering Science 0
Engineering Design 0

APSC 132 Chemistry and its Applications W | 3.3

Lecture: 2.8
Lab: 0
Tutorial: 0.5
This course combines fundamentals of chemistry with the engineering issues associated with them. Areas of study are entropy and the second law of thermodynamics, thermodynamics, chemical equilibrium, electrochemistry, chemical kinetics and organic chemistry. Environmental issues associated with each of these topics will be incorporated into lectures when appropriate.

Academic Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 10
Engineering Design 0

PREREQUISITE(S): APSC 131

APSC 142 Introduction to Computer Programming for Engineers F/W | 3

Lecture: 2
Lab: 1
Tutorial: 0
This course introduces concepts, theory and practice of computer programming. Implementation uses microcomputers. The emphasis is on the design of correct and efficient algorithms and on programming style. Applications are made to engineering problems. NOTE: The fall term delivery of this course is intended for students in the ECE direct-entry program, and enrolment in this term will require permission of the Associate Dean (Academic).

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

APSC 143 Introduction to Computer Programming for Engineers F | 3.3

Lecture: 2
Lab: 1.3
Tutorial: 0
This course introduces concepts, theory and practice of computer programming. Implementation uses microcomputers. The emphasis is on the design of correct and efficient algorithms and on programming style. Applications are made to engineering problems.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 40
Engineering Design 0

APSC 151 Earth Systems Engineering F | 3.3

Lecture: 2.8
Lab: 0.5
Tutorial: 0
This course provides an introduction to the complex Earth System (the solid earth, hydrosphere, atmosphere, and biosphere) and our interactions with it. The science behind our exploration and understanding of our planet and its ongoing evolution is explored in combination with the engineering geology of geo-materials, geo-resources, geo-dynamics and geo-risk. The connection between the Earth System and human activity is explored in depth, including local and global-scale impacts of engineering works, geopolitics, and resource issues. Examples of the terrestrial sources of geo-materials used in engineering activities are highlighted along with the technical, social, economic and environmental challenges associated with their life cycle including sustainability, contamination, biodiversity loss, social impact and climate change.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 10
Engineering Science 12
Engineering Design 0

APSC 161 Engineering Graphics W | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
The principal objectives of the course are (1) to develop the student's ability to visualize and communicate three-dimensional shapes and (2) to acquire the skills needed to use computer-aided design software. Topics covered are orthographic projection, isometric sketching, auxiliary and section views as well as dimensioning and working drawings. Computer-aided design software is used to create solid models of the parts and assemblies as well as to generate dimensioned drawings. Students apply their learning in a project where they design their own version of a consumer product. Students learn by hands-on exercises in free-hand sketching and computer-based drawing.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 37
Engineering Design 5

APSC 162 Engineering Graphics W | 2.5

Lecture: 1.5
Lab: 1
Tutorial: 0
The principal objectives of the course are (1) to develop the student's ability to visualize and communicate three-dimensional shapes and (2) to acquire the skills needed to use computer-aided design software. Topics covered are orthographic projection, isometric sketching, auxiliary and section views as well as dimensioning and working drawings. Computer-aided design software is used to create solid models of the parts and assemblies as well as to generate dimensioned drawings. Students apply their learning in a project where they design their own version of a consumer product. Students learn by hands-on exercises in free-hand sketching and computer-based drawing.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 10

APSC 171 Calculus I F | 3.3

Lecture: 2.8
Lab: 0
Tutorial: 0.5
Graphs and derivatives of vector-valued functions; related applications. Implicit derivatives and related rate applications. Fundamental Theorem of Calculus, Riemann integral; applications to problems involving areas, volumes, mass, charge, work, etc. Integration by substitution, by parts, and partial fractions. Introduction to second-order differential equations and complex numbers.

Academic Units:
Mathematics 40
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

APSC 172 Calculus II W | 3.3

Lecture: 2.8
Lab: 0
Tutorial: 0.5
This course continues calculus concepts from APSC 171, including space curves, speed, and velocity. Functions of several variables, partial derivatives, differentials, error estimates, gradient, maxima and minima. Double and triple integrals, polar and cylindrical coordinates; applications to mass, center of mass, moment. Series, power series; Taylor polynomial approximations, error analysis.

Academic Units:
Mathematics 40
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 171

APSC 174 Introduction to Linear Algebra W, S | 3.3

Lecture: 2.8
Lab: 0
Tutorial: 0.5
Systems of linear equations; real vectors spaces and subspaces; linear combinations and linear spans; linear dependence and linear independence; applications to systems of linear equations and their solution via Gaussian elimination; bases and dimension of real vector spaces; linear transformations, range, kernel and Rank-Nullity theorem; matrix representation of a linear

transformation; composition of linear transformations and matrix multiplication; invertible matrices and determinants; eigenvalues and eigenvectors of square matrices. Applications of the course material to engineering systems are illustrated.

Academic Units:
Mathematics 40
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

APSC 182 Applied Engineering Mechanics W, F, S | 1.7

Lecture: 1.45
Lab: 0
Tutorial: 0.25
Identification, visualization and quantification of forces on elements and forces within statically determinate engineering structures and systems. Two- and three-dimensional force equilibrium of rigid bodies; force distribution within engineering systems like simple trusses, frames and machines; internal shear forces and bending moments in force carrying elements; and engineering stress and strain.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 5

APSC 191 Deleted - Professional Engineering Skills FW | 3.5

Lecture: 1.25
Lab: 0
Tutorial: 2.25
This course is identical in content to APSC 190. The material normally delivered in APSC 190 in the first week of the winter term will be covered in evening sessions in the fall term in APSC 191. COURSE DELETED 2016-2017

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Science 0
Engineering Design 0

APSC 199 English Proficiency for Engineers FW, S | K0.2

Lecture: No
Lab: No
Tutorial: No
This course develops skills that are necessary to organize and present technical information in a professional context. At the end of the course students will demonstrate English proficiency in listening comprehension and written expression.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 1
Engineering Science 0
Engineering Design 0

APSC 200 Engineering Design and Practice II F/W | K4

Lecture: Yes
Lab: No
Tutorial: Yes
In this course students will participate constructively on teams to create solutions to open-ended complex problems, using standard design methods and tools. This project-based course provides instruction primarily in the first 6 weeks of the semester focusing on problem scoping, creativity and idea generation, decision making incorporating technical, economic, societal, and environmental factors, safety, engineering codes and regulations, and engineering ethics. The final 6 weeks of the course centre around a design project delivered by each discipline. This course is integrated with APSC 293, and coordinated by the same instructor.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 36

PREREQUISITE(S): APSC 100 or APSC 103 ; APSC 199 or have passed the English Proficiency Test
COREQUISITE(S): APSC 293
EXCLUSION(S): APSC 202

APSC 202 Engineering Design and Practice II: Client-Based Design W | K4.3

Lecture: 0
Lab: 0
Tutorial: 0
In this course students will participate constructively on teams to create solutions to client-based open-ended design problems using standard design methods and tools. This project-based course provides instruction on problem scoping, creativity and idea generation, decision making incorporating technical, economic, societal, and environmental factors, safety, engineering codes and regulations, and engineering ethics. Students work in teams to define problems, gather and identify appropriate information, work effectively with teammates, generate ideas, select ideas, and implement a solution to a presented problem from a client. This course is integrated with APSC 293, and taught by the same instructor. NOTE: This course is only open to students transferring into year 2 or above of a Queen's Engineering program.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 16
Engineering Science 0
Engineering Design 36

PREREQUISITE(S): APSC 101 and permission of the Associate Dean (Academic)
COREQUISITE(S): APSC 293
EXCLUSION(S): APSC 100, APSC 103, and APSC 200

APSC 221 Economics and Business Practices in Engineering F/W/S | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course will provide the student in the Engineering program with the ability to appropriately incorporate selected economic and business practices into the practice of engineering. The practices covered include: business planning for the enterprise, enterprise economic analysis, project management process, project economic analysis, risk analysis and management, quality management and change management. Assignments and examples are based on situations from engineering based industries. **Also Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

EXCLUSION(S): APSC 321, COMM 244

APSC 223 Global Project Management S | K3

Lecture: Yes
Lab: Yes
Tutorial: Yes
This course will cover the knowledge areas and processes of the globally-recognized PM Body of Knowledge: integration, scope, cost, time, risk, human resources, stakeholders and procurement management. The focus will be a practical, applied approach, utilizing the global city of London, its engineering firms, experts, practitioners and massive engineering undertakings (The Shard, Cross-Rail, the Eurotunnel, the Thames Barrier, etc.) to investigate the problems, challenges and successes of managing global engineering projects. Note that the first week of instruction for this course will be held at Queen's, prior to the start of the 6-week BISC-based workshop.

Academic Units:
Complementary Studies 36
PREREQUISITE(S): APSC 221 or CHEE 310 or permission of the instructor. Students should have taken engineering economics prior to taking the Global Project Management courses, however it is not critical, if you have not yet completed APSC 221 or CHEE 310, please e-mail the Associate Dean (Academic) at engineering.academic@queensu.ca to discuss the possibility of a prerequisite waiver.

APSC 250 Biology Through an Engineering Lens S/OL | K3.5

Lecture: Y
Lab: N
Tutorial: N
This course provides an introduction to biology and biochemistry, and their applications in cell-based engineering systems and processes. Students will obtain a basic background in biology, including the biology of bacteria, fungi, viruses and human cells. These concepts will be related to applications relevant to modern engineering and will be taught from a systems engineering perspective through the lens of societal need. This will include such applications as; bioremediation for the treatment of waste water, production of vaccines, biomedical and biomechanical devices, and regenerative medicine. While taught from an engineering perspective, the course would be relevant to any student interested in the application of biology, and is designed to provide relevant examples across multiple disciplines. The course assumes basic first year level science knowledge.

Academic Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 12
Engineering Design 0

EXCLUSION(S): CHEE 229

APSC 262 NOT OFFERED THIS YEAR: Engineering Surveying | 3.25

Lecture: 1.5
Lab: 0
Tutorial: 1.75
This introductory course in plane surveying consists of about 16 hours of lectures, the rest of the time being spent in the field. Lecture material includes distance measurement, differential, profile and indirect leveling and use of transit, traversing and mapping. Errors, corrections and balancing are also discussed. The use of available software packages for the reduction and calculation of data is encouraged throughout the course. In the field, students practice the basic techniques of instrument use through various assignments. Careful and efficient handling of instruments and proper note-keeping are stressed. The use of state-of-the-art electronic surveying instruments is included in the field assignments wherever possible. The school is held on campus immediately following the final First Year examination in April.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 40
Engineering Design 0

EXCLUSION(S): CIVL 211

APSC 291 NOT OFFERED THIS YEAR: Engineering Communications I F | 1

Lecture: 0.5
Lab: 0
Tutorial: 0.5
This course provides an introduction to effective engineering writing and speaking skills with the emphasis on technical proposals, professional correspondence, engineering reports, and oral briefings. These skills are developed in lectures and small group tutorials.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): Permission of Instructor

EXCLUSION(S): CHEE 260, ELEC 291, GEOE 291 (GEOL 291), GEOE 292 (GEOL 292), MECH 290

APSC 292 Deleted - Engineering Communications II W | 1.25

Lecture: 0.5
Lab: 0
Tutorial: 0.75
This course continues to develop skills in engineering writing and speaking from APSC 291, focusing on product specifications and evaluations, engineering reports, and formal oral presentations. These skills are developed in lectures and small group tutorials. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 291
EXCLUSION(S): CHEE 260, ELEC 291, ELEC 391, MECH 290, GEOE 291 (GEOL 291), GEOE 292 (GEOL 292)

APSC 293 Engineering Communications l F/W | K1

Lecture: Yes
Lab: No
Tutorial: Yes
This course provides an introduction to effective engineering writing and speaking skills with the emphasis on professional correspondence, engineering reports, oral briefings, and formal oral presentations. These skills are developed in lectures and small group tutorials. This course is integrated with APSC 200, and coordinated by the same instructor.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 100 or APSC 103
COREQUISITE(S): APSC 200 or APSC 202 or permission of instructor

EXCLUSION(S): APSC 292, CHEE 260, ELEC 291, ELEC 391, GEOL 291, GEOL 292, MECH 290

APSC 301 Professional Internship | 3.5

The professional internship involves spending a minimum of twelve months and a maximum of sixteen months in a paid internship position in industry or government. Students in the 12-month internship must register in APSC 302, APSC 303 and either APSC 301 or APSC 304. Students in the 16 month placement take APSC 301, APSC 302, APSC 303 and APSC 304. The nature of the work must satisfy the criteria defining professional experience for licensure as a Professional Engineer in Canada. The course includes prior workshops on interviewing, resume preparation and work performance. Successful completion of the course requires submission of a report of high quality on the experience within thirty days of completion of the work period. Career Services manage the non-academic aspects of the course.

Academic Units:
Complementary Studies 21
Engineering Science 21
PREREQUISITE(S): APSC 199 and completion of second year courses

APSC 302 Professional Internship | 3.5

The professional internship involves spending a minimum of twelve months and a maximum of sixteen months in a paid internship position in industry or government. Students in the 12-month internship must register in APSC 302, APSC 303 and either APSC 301 or APSC 304. Students in the 16-month placement take APSC 301, APSC 302, APSC 303 and APSC 304. The Internship Coordinator must be satisfied that the work carried out has educational merit. The course includes workshops on interviewing, resume preparation and work performance. Successful completion of the course requires submission of a report of high quality on the experience within thirty days of completion of the work period. Career Services manage the non-academic aspects of the course.

Academic Units:
Complementary Studies 21
Engineering Science 21
PREREQUISITE(S): APSC 199 and completion of second year courses

APSC 303 Professional Internship | 3.5

The professional internship involves spending a minimum of twelve months and a maximum of sixteen months in a paid internship position in industry or government. Students in the 12-month internship must register in APSC 302, APSC 303 and either APSC 301 or APSC 304. Students in the 16-month placement take APSC 301, APSC 302, APSC 303 and APSC 304. The Internship Coordinator must be satisfied that the work carried out has educational merit. The course includes workshops on interviewing, resume preparation and work performance. Successful completion of the course requires submission of a report of high quality on the experience within thirty days of completion of the work period. Career Services manage the non-academic aspects of the course. Note that some programs may accept this course as part of their technical elective requirements. Credit may only be granted to students who have successfully fulfilled the necessary requirements to receive the Professional Internship designation.

Academic Units:
Complementary Studies 21
Engineering Science 21
PREREQUISITE(S): APSC 302

APSC 304 Professional Internship | 3.5

The professional internship involves spending a minimum of twelve months and a maximum of sixteen months in a paid internship position in industry or government. Students in the 12-month internship must register in APSC 302, APSC 303 and either APSC 301 or APSC 304. Students in the 16-month placement take APSC 301, APSC 302, APSC 303 and APSC 304. The Internship Coordinator must be satisfied that the work carried out has educational merit. The course includes workshops on interviewing, resume preparation and work performance. Successful completion of the course requires submission of a report of high quality on the experience within thirty days of completion of the work period. Career Services manage the non-academic aspects of the course.

Academic Units:
Complementary Studies 21
Engineering Science 21
PREREQUISITE(S): APSC 303

APSC 321 Deleted - Economic and Business Practices in Mining and Geological Engineering |

This course will provide the student in the Mining Engineering or Geological Engineering program with the ability to appropriately incorporate selected economic and business practices into the practice of engineering. The practices covered include: business planning for the enterprise, enterprise economic analysis, project management process, project economic analysis, risk analysis and management, quality management and change management. Assignments, examples, and tutorials are based on current situations from the Mining and Geological Engineering based industries. - COURSE DELETED 2013-2014

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Science 0
Engineering Design 0

EXCLUSION(S): APSC 221, COMM 244, GEOL 472

APSC 381 Advanced Design and Skills for Innovation W | K3.5

Lecture: Yes
Lab: No
Tutorial: Yes
This multidisciplinary project-based course will provide students with a broad range of knowledge and skills for design and innovation. Topics span the breadth of the innovation process, including advanced topics such as risk analysis, FMEA, reliability, and elements of six sigma methodologies. Elements of project management, market and economic analysis, and other professional practice topics are interwoven. Students work in multidisciplinary teams on relevant and realistic projects, simulating the real-world engineering environment.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 42

PREREQUISITE(S): Successful completion of all second year core courses. Only students registered in year 3 can add APSC 381 on SOLUS. If the course is full, you may contact the instructor to be added to a waiting list. Students registered as year 4 or above may contact the instructor for permission to enrol in the course.

APSC 400 NOT OFFERED 2021-2022 Technology, Engineering & Management (TEAM) FW* | K7

Lecture: Yes
Lab: No
Tutorial: Yes
Multidisciplinary teams of engineering, commerce, law, and/or science students, as appropriate, undertake consulting projects with industrial, government, and not-for-profit clients. Typical project types include Process Improvement, Feasibility & Design, Business Strategy/Marketing, Environmental, Start-ups, Blue-Sky, or a combination of topics which are selected based on prevailing industry trends. Following a phase of self-directed problem and scope definition, students will execute their projects in groups, guided by experienced professionals. Students will receive formal training in project management and participate in guest lectures by industry experts. Students interact regularly with clients at a technical and management level. The course concludes with a comprehensive report and presentation to the client. Participation in the course is by selection. Students must apply for admission into the

course by providing a copy of their resume, unofficial transcript, and a cover letter substantiating their interest in the course.
More information can be found on the course website: http://team.appsci.queensu.ca/ ***Replaced CHEE 400**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Science 0
Engineering Design 42

PREREQUISITE(S): Completion of 3rd year core courses and permission of the instructor.
EXCLUSION(S): APSC 401

APSC 401 Interdisciplinary Projects W | K4.5

Lecture: Yes
Lab: No
Tutorial: Yes
Multidisciplinary teams of engineering, commerce, law, science, social science, and humanities students, as appropriate, undertake consulting projects with industrial, government, and not-for-profit clients. Typical project types include social innovation, process improvement, business strategy/marketing, environmental, start-ups, blue-sky, or a combination of topics which are selected based on societal and industry interests. This is a winter term course, but students will meet with their teams and client at the end of the fall term. Following a phase of self-directed problem and scope definition, students will execute their projects in groups, guided by experienced professionals. Students will receive formal training in project management, effective teaming, client interaction, and communication in professional environments. Students interact regularly with clients at a technical and management level. The course concludes with a comprehensive report and presentation to the client. Participation in the course is by selection. Students must apply for admission into the course by providing a copy of their resume, unofficial transcript, and a cover letter substantiating their interest in the course. This course is co-taught with instructors teaching the equivalent courses in other Faculties.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 27
Engineering Science 0
Engineering Design 27

PREREQUISITE(S): Completion of 3rd year core courses and permission of the instructor.
EXCLUSION(S): APSC 400

APSC 480 Multi-disciplinary Industry Engineering Design Project FW | K9

Lecture: Yes
Lab: No
Tutorial: Yes
This course will enhance student's design, innovation, critical thinking, and professional skills by experiencing real-time industry-funded projects. Working in multidisciplinary teams, students are guided by experienced engineering professionals both internally and externally. Teams interface frequently with the client, including occasional external site visits. Projects cover a broad range of engineering disciplines, and often incorporate the development of physical prototype(s) or digital models/simulations for evaluation and testing, as well as techno-economic elements. Students will integrate elements of engineering design, innovation, and professional practice from prior courses, with enhancements from occasional lectures, workshops, and guest speakers. Project funding supports all necessary travel, communication, software, equipment, prototyping components and related services. Professional engineering skills such as communication, teamwork, project management, engineering economics, ethics, and safety will be integral to the projects.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 0
Engineering Design 80

PREREQUISITE(S): Enrolment may be requested by contacting the Instructor.

Biochemistry

BCHM 315 Proteins and Enzymes F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Principles of protein biochemistry, enzymology, and protein engineering.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 281 (CHEM 281) and CHEM 282, or ENCH 211 (CHEM 211) and

ENCH 212 (CHEM 212) and ENCH 245 (CHEM 245), or permission of the department.
EXCLUSION(S): BCHM 310

Biology

BIOL 205 Mendelian and Molecular Genetics F | 3

Lecture: 3
Lab: 1.5
Tutorial: 0
An introduction to Mendelian and molecular genetics covering the basic mechanisms of genetic transmission, gene structure and function, as well as the application of molecular genetics in medicine and biotechnology. NOTE: Course weighting is defined by the Faculty of Arts and Science

Academic Units:
Mathematics 0
Natural Sciences 54
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): BIOL 102, BIOL 103

BIOL 335 Limnology and Aquatic Ecology F | 3

Lecture: 3
Lab: 1.5
Tutorial: 0
Physics, chemistry and biology of freshwater lakes. Emphasis on: morphometry; light and temperature; water chemistry in relation to nutrients; physiological requirements; composition and interaction of algal and invertebrate populations; eutrophication; pollution; environmental change. NOTE: Course weighting is defined by the Faculty of Arts and Science NOTE: BIOL 200 (or BIOL 201 and BIOL 202) highly recommended.

Academic Units:
Mathematics 0
Natural Sciences 54
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): CHEM 112, or APSC 131 and APSC 132.

Chemical Engineering

CHEE 209 Analysis of Process Data F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Statistical methods for analyzing and interpreting process data are discussed, . Topics include: role of data in assessing process operation, identifying major problems, graphical and numerical summaries, principles of valid inference, probability distributions for discrete and continuous data, and an introduction to linear regression analysis.

Academic Units:
Mathematics 27
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 0

PREREQUISITE(S): APSC 171 , APSC 172 , APSC 174
EXCLUSION(S): STAT 268, STAT 269, MTHE 367

CHEE 210 Thermodynamics of Energy Conversion Systems W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course is an introduction to thermodynamics for chemical engineering systems analysis. The principles arising from First and Second laws of thermodynamics will be applied to the solution of mass, energy, and entropy balances for homogeneous closed and open systems. Properties of ideal gases and real fluids will be derived from Equations of State and applied in the analysis of simple flow processes. The students will compute efficiencies and coefficients of performance for energy production, conversion, and storage systems. The impacts of energy process design choices on efficiency, performance, and sustainability will be measured through exergy analysis.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): CHEE 221 (or MINE 201)
COREQUISITE(S): None

CHEE 218 Laboratory Projects I W | 2.5

Lecture: 0.15
Lab: 2
Tutorial: 0.35
The projects provide a practical introduction to processes that occur in chemical engineering operations. Bench-scale and pilot plant equipment are used. Students plan and carry out the experiments, analyze the data and prepare written reports

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 10
Engineering Science 20
Engineering Design 0

PREREQUISITE(S): APSC 100 (or APSC 102), CHEE 209, or permission of the department.

CHEE 221 Chemical Processes and Systems F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction to the fundamentals and principles of chemical engineering, with applications to chemical and biochemical processes, via an analysis of processing units including distillation, crystallization and combustion. Specific topics include conservation equations for mass and energy, process flow diagrams, material and energy balances, chemical reaction fundamentals, and applications of the First Law of Thermodynamics.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132, APSC 172, or permission of the department

CHEE 222 Process Dynamics and Numerical Methods W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Time-varying operation of chemical and biochemical processes is introduced. Dynamic

mathematical models are formulated using material and energy balances. Effects of operational and design parameters on steady-state and dynamic operations are investigated. Numerical techniques are introduced to solve systems of algebraic and differential equations. Numerical and symbolic computation tools are used to analyze dynamic and steady-state process behaviour.

Academic Units:
Mathematics 22
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 0

PREREQUISITE(S): APSC 143 or MNTC 313, CHEE 221, MTHE 225 (MATH 225) or permission of the department

CHEE 223 Fluid Mechanics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Principles of momentum and energy transport are applied to the analysis of fluid systems commonly encountered in chemical engineering practice. This approach is via the macroscopic and differential balances of mass, momentum and energy. Topics include fluid statics; incompressible flow in closed conduits; flow and pressure measurement; transportation of fluids; laminar, turbulent and creeping flows; boundary layer effects; sizing of commercial components (piping, tubing, valves, pressure and flow meters and other fittings, as well as pumps) for fluid transport systems in industrial settings.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): CHEE 221, MTHE 225 (MATH 225)
COREQUISITE(S): None

CHEE 224 Transport Phenomena Fundamentals F | 3

Lecture: 2
Lab: 0
Tutorial: 1
The theory and mathematical framework of transport phenomena are introduced. Mass, energy

and momentum balances are developed using the integral and differential methods of analysis. The tools used to formulate and solve the problems include representation of physical entities in vector form, multivariable functions and vector operations in 2D and 3D. Specific topics of Chemical Engineering interest include moments of a force, work done by a force, moments of inertia, control surfaces and control volumes and fluid kinematics.

Academic Units:
Mathematics 18
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172

CHEE 229 Cell Based Engineering Principles F | 4

Lecture: 3
Lab: 0.75
Tutorial: 0.25
Introduction to the Biological, Biochemical and Life Science principles of cell/ enzyme-based engineering systems and processes. The emphasis will be placed on microbial cell culture, but comparisons will be drawn to related systems including viral, plant and animal cell culture as it relates to medicine, industrial practice or the environment.

Academic Units:
Mathematics 0
Natural Sciences 35
Complementary Studies 0
Engineering Science 13
Engineering Design 0

PREREQUISITE(S): APSC 131 and APSC 132; or equivalents or permission of the Department.
EXCLUSION(S): MICR 221

CHEE 270 ChemEtronics F | K3

Lecture: Y
Lab: Y
Tutorial: N
This course combines elements of chemical and electrical engineering to measure, calculate and control electrical signals. The course introduces basic electrical circuit analysis theory with an emphasis on concepts utilized in analytical chemistry instrumentation and energy conversion and storage. An introduction to signal analysis, data acquisition, sampling and quantization, as well

as the fundamental statistical techniques necessary to process and analyze measured data with uncertainty is given. Course content is delivered via a blended offering with on-line instruction and active learning sessions.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): APSC 112 and APSC 143 or MNTC 313

CHEE 302 Technical Entrepreneurship W/OL, F/OL | K3.5

Lecture: Y
Lab: N
Tutorial: N
This course will help learners from all disciplines develop an entrepreneurial mindset capable of turning problems into opportunities. Learners will identify sources, rates, and directions of technological change, and begin to understand the role and challenges of technological innovation across sectors, countries, and organizations. Learners will investigate the relationships between innovation and industrial dynamics, and seek to understand the fundamental forces that drive the science and technology industries' evolution and industry life cycles. In the process, learners will explore frameworks and tools used to analyze new technology adoption, predict technology diffusion patterns, and assess the strategic value of technological innovation.
NOTE: Offered only at the Bader International Study Centre, Herstmonceux, in the fall term.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Science 0
Engineering Design 0

EXCLUSION(S): CHEE 310, CHEE 410

CHEE 310 Deleted-Engineering Innovation and Entrepreneurship F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This is a course about innovation – distinctive ideas, of value, put to practice – and entrepreneurship – the process of putting to practice and sustaining the implementation of

innovations – for societal benefit and wealth creation. Curiosity of the world around us is emphasized for identifying opportunities to have an impact and make a difference, to which a discipline is imposed - one that identifies who might be interested in or benefit from our product or service, and how we can bring an idea to fruition and provide the necessary resources (e.g., financial, intellectual) to provide it to society. Legal aspects (e.g., incorporation, partnerships), raising capital, and protecting the strategic advantage of intellectual property (e.g., patents, trade secrets) are discussed, together with the importance of having a social license to operate. The concept of a business model, summarized using the business model canvas methodology, is presented, together with the concept of a business plan describing how a venture will be operated over a time horizon. For-profit and not-for-profit ventures, and the elements of the business models for each, are studied and compared. Financial metrics for assessing the viability of ventures and guiding investment decisions are presented (e.g., IRR, NPV, EBITDA). Systems Thinking (recognizing the whole/parts and that which is common/distinct) is introduced. Design Thinking – a human-centered design emphasizing observation and experimentation gaining traction in engineering, business and social sciences – is presented. Working in groups, students identify a venture opportunity having a technological component, and propose a business model and plan as the major evaluation in the course. Nov. 2018

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Science 0
Engineering Design 0

CHEE 311 Fluid Phase and Reaction Equilibrium F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course is concerned with the application of thermodynamics to practical problems of the chemical industry. Emphasis is placed on the study of phase equilibrium, including vapour-liquid equilibrium and liquid-liquid equilibrium. Contemporary methods of calculating the thermodynamic properties of non-ideal vapours and liquids will be presented and applied. The principles of chemical reaction equilibrium will also be studied. The design component of the course will require students to perform theoretical vapour-liquid equilibrium calculations and recommend proper operating conditions for a single-stage unit (flash drum) that separates a non-ideal binary mixture.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30

Engineering Design 12

PREREQUISITE(S): CHEE 210

CHEE 315 Laboratory Projects II F/W | 4

Lecture: 0.25
Lab: 3
Tutorial: 0.75
The main objectives are to develop skill in using process and analytical equipment, to examine the strengths, weaknesses, and limitations of current theory, to improve the student's ability to obtain and interpret data, to demonstrate the value of planning experiments, to develop engineering judgement, and to provide experience in oral and written reporting.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 16
Engineering Science 32
Engineering Design 0

PREREQUISITE(S): CHEE 222 and CHEE 223

CHEE 319 Process Dynamics and Control W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The dynamic behaviour and automatic control of processes are studied. Mathematical tools for analyzing the transient behaviour of open and closed-loop systems are presented. The steps of controller development are treated: process characterization (using mathematical models), controller design, and implementation. Methods for assessing system stability and performance are investigated, and are used in the design of controllers. Frequency response methods are introduced, as is the development and implementation of controller enhancements including feedforward and cascade control.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): CHEE 222 or MINE 201, MTHE 225 (MATH 225), CHEE 321 or permission of the department.

CHEE 321 Chemical Reaction Engineering F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides a detailed and in-depth analysis to the principles of chemical kinetics, and reactor analysis and design. The topics in chemical kinetics include: rate constants, reaction order, rate equations for elementary and complex reactions, kinetic data analysis, and product distribution. In reactor analysis and design, discussion is focused on ideal reactor systems and arrangements, including batch reactors, plug flow reactors, continuous stirred tank reactors, and recycle reactors. The last part of the course considers homogeneous and heterogeneous catalytic reactions. The design component consists of how to make an appropriate choice of reactor type and operating conditions to optimize a desired product; sizing such reactors and determining conversion levels under various conditions of temperature and pressure; determination of reaction kinetics from experimental data.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): CHEE 210, (CHEE 222 or MINE 201), or permission of the department.

CHEE 323 Industrial Catalysis W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Students will learn, discuss and apply knowledge of the chemical structure and reactivity of industrial catalytic compounds, with particular emphasis placed upon the integration of fundamental catalytic chemistry with the principles of chemical reaction engineering, transport phenomena and thermodynamics. Industrial processes of interest include homogeneous ionic, radical, and coordinative catalytic systems, as well as heterogeneous fluid-solid systems. The design component of the course will require students to develop catalytic processes to meet productivity targets from provided kinetic and thermodynamic data.

Academic Units:
Mathematics 0
Natural Sciences 11

Complementary Studies 0
Engineering Science 20
Engineering Design 11

PREREQUISITE(S): ENCH 245, CHEE 321, CHEE 330 or permission of the Chemical Engineering department

CHEE 324 NOT OFFERED 2021-2022 Organic Process Development W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Students will expand their knowledge of functional group interconversions and C-C bond forming reactions learned in ENCH 245, and apply retrosynthetic analysis to propose multi-step syntheses of organic target molecules. Selection of reagents, solvents and reaction conditions will be examined in the context of process safety, reaction yield, product isolation, and profitability. This will be followed by studies of target molecule recovery by extraction, recrystallization, distillation and chromatography. The design component of the course is a series of two-hour design challenges in which student teams generate solutions to process development problems. This includes proposing reaction sequences for producing a target molecule, conducting safety analyses of hazardous reactions, choosing from multiple synthetic routes, and recommending separation trains for product isolation.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 15
Engineering Design 15

PREREQUISITE(S): ENCH 245 and CHEE 311
EXCLUSION(S): ENCH 345

CHEE 330 Heat and Mass Transfer F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course follows a unified approach to introduce the physical origins and rate equations of heat and mass transfer. The principal topics covered include identification of the driving forces for heat and mass diffusion, development of transport models from first principles, steady state and transient solutions, and convective transfer. The boundary layer analogies are introduced. Closed form analytical solutions and correlations derived from dimensional analysis are used to estimate the heat and mass transfer convection coefficients.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): CHEE 210, CHEE 223, or permission of the department.

CHEE 331 Design of Unit Operations W | K4.5

Lecture: Yes
Lab: No
Tutorial: Yes
This course is part of the Engineering Design and Practice Sequence. Heat and mass transfer knowledge is applied in the analysis and design of unit operations, including separation processes and heat exchanging equipment. The equilibrium stage concept is used to perform calculations and size separation processes including distillation, gas absorption/stripping and liquid-liquid extraction. Heat transfer processes are taught with an emphasis on the design various types of heat exchanging equipment, including shell and tube heat exchangers, condensers and reboilers. The chemical process design component of the course involves a series of activities, dealing with the design of separation processes, heat exchanger sizing and design, process hazards analysis, implementation of instrumentation and construction of piping and instrument diagrams. In addition to choosing and sizing unit operations and implementing appropriate process instrumentation, the students will learn to use simulation tools and will incorporate economics, safety and environmental responsibility in all stages of the design. The course is integrated with CHEE 361 "Engineering Communications, Ethics and Professionalism."

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 40

PREREQUISITE(S): APSC 200 or APSC 202, APSC 293, CHEE 311, CHEE 321, CHEE 330, or permission of the department.
COREQUISITE(S): CHEE 361

CHEE 332 Design of Unit Operations (DELETED) W | K 4.5

Lecture: yes
Lab: no

Tutorial: yes
This course is part of the Engineering Design and Practice Sequence offered at the 3rd year level to students following the Chemical Engineering CHE2 Option. Heat and mass transfer knowledge is applied in the analysis and design of unit operations, including separation processes and heat exchanging equipment. The equilibrium stage concept is used to perform calculations and size separation processes including distillation, gas absorption/stripping and liquid-liquid extraction. Heat transfer processes are taught with an emphasis on the design various types of heat exchanging equipment, including shell and tube heat exchangers, condensers and reboilers. The chemical process design component of the course involves a series of activities, dealing with the design of separation processes, with an emphasis on bioseparations, heat exchanger sizing and design, process hazards analysis, implementation of instrumentation and construction of piping and instrument diagrams. In addition to choosing and sizing unit operations and implementing appropriate process instrumentation, the students will learn to use simulation tools and will incorporate economics, safety and environmental responsibility in all stages of the design. The course is integrated with CHEE 361 "Engineering Communications, Ethics and Professionalism." Yes

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 42

PREREQUISITE(S): APSC 200or APSC 202, APSC 293, CHEE 311, CHEE 321, CHEE 330, or permission of the department.
COREQUISITE(S): CHEE 361

CHEE 333 Design of Unit Operations (DELETED) W | K 4.5

Lecture: yes
Lab: no
Tutorial: yes
This course is part of the Engineering Design and Practice Sequence offered at the 3rd year level to Engineering Chemistry students. Heat and mass transfer knowledge is applied in the analysis and design of unit operations, including separation processes and heat exchanging equipment. The equilibrium stage concept is used to perform calculations and size separation processes including distillation, gas absorption/stripping and liquid-liquid extraction. Heat transfer processes are taught with an emphasis on the design various types of heat exchanging equipment, including shell and tube heat exchangers, condensers and reboilers. The chemical process design component of the course involves a series of activities, dealing with the design of separation processes for industrial chemicals, heat exchanger sizing and design, process hazards analysis, implementation of instrumentation and construction of piping and instrument diagrams. In addition to choosing and sizing unit operations and implementing appropriate process

instrumentation, the students will learn to use simulation tools and will incorporate economics, safety and environmental responsibility in all stages of the design. The course is integrated with CHEE 361 "Engineering Communications, Ethics and Professionalism." Yes

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 42

PREREQUISITE(S): APSC 200 or APSC 202, APSC 293, CHEE 311, CHEE 321, CHEE 330, or permission of the department.
COREQUISITE(S): CHEE 361

CHEE 340 Biomedical Engineering W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course will provide students with a fundamental understanding of cell biology, human physiology and the application of engineering principles (momentum and mass transfer, mechanics, materials) for the solution of medical problems. Topics include: Cell Biology, Anatomy and Physiology, Transport Phenomena in the Body, Biomechanics, Materials in Medicine, and Regenerative Medicine and Tissue Engineering.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0

EXCLUSION(S): CHEE 442

CHEE 342 Environmental Biotechnology F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course gives a broad perspective of the use of microbial systems to treat environmental pollutants and of microorganisms as potential environmental contaminants. Biogeochemical cycles and their applications to processes such as the desulphurization of coal and crude oil, biocorrosion, mineral (eg. uranium, copper and iron) leaching, the degradation of organic

compounds, and nitrate removal from drinking water will be studied. Microbial waste disposal systems such as composting and soil bioremediation and the role of biotechnology in waste minimization will be examined. Microorganisms found in air, soil and water, their detection, enumeration and control will be discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

CHEE 360 Deleted - Technical Communications W | 1.5

Lecture: 0.75
Lab: 0
Tutorial: 0.75
This course provides advanced instruction and practice in effective technical writing and oral presentation. Most exercises will be linked to required oral and written communications tasks in other courses. Open to Chemical Engineering and Engineering chemistry students only. Deleted 2016-2017

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 0
Engineering Design 0

COREQUISITE(S): CHEE 331 or CHEE 332 or CHEE 333, or permission of the Department

CHEE 361 Engineering Communications, Ethics & Professionalism W | K1

Lecture: Yes
Lab: Yes
Tutorial: Yes
This course provides advanced instruction and practice in engineering communications, engineering ethics and professionalism. Effective engineering writing and speaking skills are developed with an emphasis on engineering reports and oral presentations. Students will learn how to gather information, apply appropriate citation styles, write effective documents, and present data effectively. Activities include case studies involving the application of codes, engineering ethics, equity and professionalism. This course is integrated with CHEE 331.

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 200 or APSC 202, APSC 293 or permission of the Department.
COREQUISITE(S): CHEE 331 or permission of the Department.

CHEE 363 Electrochemical Engineering* W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This engineering science course covers aspects of technological applications of electrochemistry. It can be considered as overlap between electrical engineering, electrochemistry and chemical engineering. The course addresses the following 7 major topics of electrochemical engineering: 1) Introduction into Electrochemical Engineering and Systems: Characteristics, Charge Conservation, Faraday's Law; 2) Elements of Electrochemical Systems I. Electrolytes: Transport processes, electrolyte conductivity, pH and buffer solutions; 3) Elements of Electrochemical Systems II. Electrodes: Electrochemical Thermodynamics, Nernst Equation, Reference Electrodes, Cell Potential, Electrochemical Kinetics; 4) Electrical Double Layers: Theory & Models, Electrokinetic Phenomena; 5) Electrochemical Characterization Methods: Cyclic Voltammetry, Electrical Impedance Spectroscopy; 6) Electrochemical Energy Engineering: Batteries, Fuel Cells, Electrical & Electrochemical Capacitors;7) Industrial Electrochemical Processes: Fundamentals, Reactor Design & Parameter, Chlor-Alkali Process, Electrochemical Extraction of Metals, Hall-Heroult Process. ***Changed from CHEE 461 to CHEE 363 Jan. 2019**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): CHEE 210, CHEE 270, CHEE 321, or permission of the department.
EXCLUSION(S): CHEE 461

CHEE 370 Deleted - Waste Treatment Processes W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5

The sources and characteristics of liquid waste streams emanating from chemical and related industries are reviewed as the basis for developing appropriate abatement and treatment strategies. Treatment processes utilizing individual operations as well as integrated systems of physical, chemical and biological treatment are covered. Waste treatment process designs and sensitivity analyses of alternatives are undertaken with the help of Computer Aided Design software. Canadian guidelines, regulations and industrial case studies are presented. Deleted 2016-2017

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 17
Engineering Design 25

PREREQUISITE(S): CHEE 221 or MINE 201, or permission of the department
EXCLUSION(S): CIVL 372, CIVL 470

CHEE 371 Mitigation of Industrial Pollution W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Sources and characteristics of waste streams emanating from chemical and related industries are reviewed as the basis for developing appropriate abatement and treatment strategies. Treatment processes utilizing individual operations as well as integrated systems of physical, chemical and biological treatment are covered. Treatment process designs and sensitivity analyses of alternatives are undertaken for case studies involving industrial solid, liquid and gaseous wastes. Canadian guidelines and regulations are presented and implemented within the context of environmental and human health.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): CHEE 221 or MINE 201, or permission of the Department.

CHEE 380 Biochemical Engineering F | 3.5

Lecture: 3
Lab: 0

Tutorial: 0.5
Biochemical Engineering involves the application of Chemical Engineering principles and approaches to biologically based systems and processes. Biochemical Engineering is central to the area of environmental engineering, and to biotechnology processes which produce pharmaceuticals, fine chemicals and genetically engineered products. The course involves a systematic and quantitative description of medium formulation and sterilization, microbial kinetics and bioreactor design, product isolation and purification, and examples of current industrial practices and processes.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): CHEE 221 or permission of the Chemical Engineering department.

CHEE 400 DELETED Technology, Engineering & Management (TEAM) FW | K7

Lecture: yes
Lab: no
Tutorial: no
Multidiscipline teams of engineering, commerce, law, and/or science students, as appropriate, act as consultants to industrial and governmental clients. Projects include a phase of self-directed problem definition and project scope definition in the fall term, followed by project execution in the winter term. Typical projects involve evaluation of technical alternatives (with an emphasis on health, safety, and environmental), preparation of detailed recommendations, and both market and financial analysis. Project topics vary widely and are provided by a diverse list of fee paying clients. The course includes seminars on project management. There are several meetings during the fall term to organize groups and select projects, but regularly scheduled lectures do not begin until the Winter term. Teams interact regularly with clients at both a technical and a management level, and are also assigned an industrial project mentor. Students master project management skills, by managing their own budget, travel arrangements etc. The course concludes with a comprehensive report and presentation to the client. The course is managed by the Department of Chemical Engineering Changed to APSC 400 Nov 2018 Nov 2018

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Science 0
Engineering Design 42

PREREQUISITE(S): Permission of the instructor

CHEE 405 DELETED - Biochemical/Biomedical Research Project FW | 7

Lecture: 0.25
Lab: 6
Tutorial: 0.75
Students will conduct research on a Biochemical/Biomedical Engineering related project. Based on the project objective provided by their faculty supervisor, the students will work independently to develop an experimental and/or modeling methodology, conduct experiments or simulations and generate data. Students will submit interim oral and written progress reports and a final oral presentation and technical report. They will be expected to present and defend their results in a conference/seminar setting. Students enrolling for this course are advised to consult with the faculty member supervisor concerned late in the winter term of their 3rd year of study. Nov. 2019

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 84
Engineering Design 0

CHEE 406 DELETED - Bioenvironmental Research Project FW | 7

Lecture: 0.25
Lab: 6
Tutorial: 0.75
Students will conduct research on a Bioenvironmental Engineering related project. Based on the project objective provided by their faculty supervisor, the students will work independently to develop an experimental and/or modeling methodology, conduct experiments or simulations and generate data. Students will submit interim oral and written progress reports and a final oral presentation and technical report. They will be expected to present and defend their results in a conference/seminar setting. Students enrolling for this course are advised to consult with the faculty member supervisor concerned late in the winter term of their 3rd year of study. Nov. 2019

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 84
Engineering Design 0

CHEE 407 Deleted - Biochemical/Biomedical/Bioenvironmental Research Seminar W | 3

Lecture: 1
Lab: 0
Tutorial: 2
Students will attend and report on a series of seminars presented by researchers in the field of Biochemical Engineering. Each student will deliver interactive seminar presentations, based on assigned topics in the field. After conducting a literature review, students will submit a review term paper, or a case study based on their reading and understanding of the literature. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 14
Engineering Science 22
Engineering Design 0

CHEE 408 Bioengineering Research Project FW | K7

Lecture: yes
Lab: yes
Tutorial: yes
Students will conduct research on a Biochemical/Biomedical/Bioenvironmental Engineering related project. Based on the project objective provided by their faculty supervisor, the students will work independently to develop an experimental and/or modeling methodology, conduct experiments or simulations and generate data. Students will submit interim oral and written progress reports and a final oral presentation and technical report. They will be expected to present and defend their results in a conference/seminar setting. Students enrolling for this course are advised to consult with the faculty member supervisor concerned late in the winter term of their 3rd year of study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 0
Engineering Design 56

CHEE 410 Engineering Innovation and Entrepreneurship W | K4

Lecture: Y
Lab: N
Tutorial: Y
This is a course about innovation – distinctive ideas, of value, put to practice – and entrepreneurship – the process of putting to practice and sustaining the implementation of

innovations – for societal benefit and wealth creation. Curiosity of the world around us is emphasized for identifying opportunities to have an impact and make a difference, to which a discipline is imposed - one that identifies who might be interested in or benefit from our product or service, and how we can bring an idea to fruition and bring the necessary resources (e.g., financial, intellectual) to provide it to society. Legal aspects (e.g., incorporation, partnerships), raising capital, and protecting the strategic advantage of intellectual property (e.g., patents, trade secrets) are discussed, together with the importance of having a social acceptance to operate. The concept of a business model, summarized using the business model canvas methodology, is presented, together with the concept of a business plan describing how a venture will be operated over a time horizon. For-profit and not-for-profit ventures, and the elements of the business models for each, are studied and compared, and intrapreneurship/entrepreneurship are compared. Financial metrics for assessing the viability of ventures and guiding investment decisions are reviewed. Systems Thinking (recognizing the whole/parts and that which is common/distinct) is introduced. Design Thinking – a human-centered design emphasizing observation and insight - is presented, along with journey maps and personas for understanding customer segments. Diffusion of innovations is described, including the factors influencing adoption of innovations, and the manner in which innovations propagate in society. Working in groups, students identify a venture opportunity having a technological component, and propose a business model and plan as the major evaluation in the course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 221
EXCLUSION(S): CHEE 302, CHEE 310

CHEE 412 Transport Phenomena W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The transport phenomena approach is followed to study and analyze transport of momentum, energy and mass, with special focus on combined transport problems. Solutions are developed for problems involving steady-state and unsteady flows, isothermal and non-isothermal conditions, as well as non-Newtonian liquids. This course completes the students' intellectual training in the transport sciences culminating in their mastery of combined transport problems, including fluid flow with heat transfer, or mass transport with fluid flow, or heat transfer with mass transport.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): CHEE 223, CHEE 224, CHEE 330, or permission of the department
EXCLUSION(S): CHEE 452

CHEE 414 Foundations of the Oil and Gas Industry W | K3.5

Lecture: Yes
Lab: No
Tutorial: Yes
Fundamentals of the oil and gas industry covering Chemical Engineering and Geological Engineering practice, and implications of Canadian and world political forces together with business practices are covered. Industry needs for exploration, recovery, processing, business expansion and policy issues will be addressed through case studies, in conjunction with examination of suitable business models.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): CHEE 221, or permission of the instructor.

CHEE 415 Engineering Chemistry Laboratory W | 4

Lecture: 0.25
Lab: 3.5
Tutorial: 0.25
Bench- and pilot-scale laboratory exercises provide students practical experience with chemical operations involving transport phenomena, thermodynamics, reaction kinetics and process control. Working with minimal supervision, student teams plan and execute experiments, analyze acquired data according to engineering science models, and communicate key findings in concise technical reports.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 48

Engineering Design 0

PREREQUISITE(S): CHEE 330
EXCLUSION(S): CHEE 315

CHEE 418 Strategies for Process Investigations F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The roles of designed experiments and data analysis procedures in process investigations are discussed. Applications of two-level factorial and fractional factorial designs in screening studies and higher-order designs for response surface characterization and exploration are examined. Least squares procedures for fitting and testing mathematical models, and for assessing model predictions, are described. Empirical in-plant optimization procedures are also considered. Established and evolving approaches for quality and productivity improvement are examined. The design component of this course is the planning and execution of an experimental investigation, the analysis of the resulting data, and the formulation of recommendations on the basis of those results.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 12

PREREQUISITE(S): CHEE 209 and CHEE 331, or permission of the department
EXCLUSION(S): STAT 361

CHEE 420 Laboratory Projects III W | K4

Lecture: Y
Lab: Y
Tutorial: Y
Students will work as teams to tackle projects that require bench and pilot plant equipment, and computer packages that simulate commercial processes. The projects will be more extensive and integrated than in previous laboratories and will require a thorough and comprehensive analysis of processes and operations. A strong emphasis is placed on project planning and management, as well as professional communication with supervisors. The design component of this course is found in the application of process analysis skills to solve problems. The projects require the students to apply critical and problem-solving skills in the operation or simulation of laboratory and process equipment with the goal of solving a problem for a fictitious industrial client. The projects may involve analysis or troubleshooting of existing equipment, or an investigation of the

applicability of a concept to a new area.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 16
Engineering Science 16
Engineering Design 16

PREREQUISITE(S): CHEE 311, CHEE 321, CHEE 330, CHEE 315, CHEE 319, or permission of the department

CHEE 421 Research Project FW | K 7

This course provides an opportunity for students to work on an individual basis with faculty members of the department. Students will submit interim oral and written progress reports and a final oral presentation and technical report. They will be expected to present and defend their results in a conference/seminar setting. The projects may be concerned with engineering design and development work or may be of a more fundamental research nature. Students enrolling for this course are advised to consult with the faculty member concerned late in the winter term of their 3rd year of study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 0
Engineering Design 56

PREREQUISITE(S): ECGPA of 3.20 or permission of the Department.

CHEE 434 Process Control II W | 3.5

Lecture: 3
Lab: 0
Tutorial: 3
This course presents methods for dynamic analysis and controller design for multivariable process control problems, and discrete time control. Control techniques, including feedforward and cascade control, are discussed further, and the concept of model predictive control is presented. Multivariable controller design and the problem of control loop interaction are examined. State space models for processes are introduced. Mathematical tools for analyzing the dynamics of sampled data systems are developed, and the design of discrete time controllers is introduced. Techniques discussed in the course are applied to the control of various chemical process units.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): CHEE 319, or permission of the department

CHEE 436 Deleted-System Identification F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The course focuses on the theory and application of linear time series methods for system identification. Time domain and frequency domain methods for analyzing dynamic data will be presented. Standard process plus disturbance models encountered in the identification literature will be investigated from both statistical and physical perspectives. Methods for structural identification, incorporation of exogenous variables, parameter estimation, inference and model adequacy will be examined in detail. The design of dynamic experiments and incorporation of model uncertainty into the intended model and use, such as prediction or control, will be discussed. Assignments will include the analysis of industrial data sets. Dynamic modelling using neural networks and nonlinear time series methods will be introduced. Nov. 2018

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 0

PREREQUISITE(S): CHEE 209, CHEE 418, or permission of the department.

CHEE 440 Pharmaceutical Technology W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Pharmaceutics and the industrial manufacture of pharmaceutical dosage forms are introduced. Topics include the design and preparation of a successful dosage form with respect to the route of administration, and large-scale manufacture in a sterile and clean environment. Aspects of chemical kinetics, physical chemistry, physiology, cell biology, mass and heat transfer, and fluid dynamics will be described as they relate to the manufacture of effective dosage forms. This

course applies engineering concepts, such as mass transfer, unit operations, thermodynamics, and basic chemistry and is recommended for students in their 3rd or 4th year of studies.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0

CHEE 450 DELETED - Engineering Biology W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Topics include: biosynthesis of biologically based products: properties of biologically active materials including enzymes, polynucleotides and polypeptides; enzyme reaction kinetics; cell and tissue growth and production kinetics; cell and tissue culture engineering; diffusion and reaction involved immobilized cells and enzymes; bioprocess instrumentation. The course project will require the design of a biological reactor or downstream unit operation, or the specification of instrumentation for a particular bioprocess. No

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): ENCH 245 (CHEM 245)

CHEE 452 Transport Phenomena in Physiological Systems F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course applies the principles of mass, momentum and heat transfer in physiological systems. The students will examine the role of transport phenomena in the function of organs and organ systems in the body, and develop the skills necessary to analyze models of biological transport processes in the context of the design of biomedical devices.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): CHEE 223 and CHEE 330, or permission of the department
EXCLUSION(S): CHEE 412

CHEE 460 Applied Surface and Colloid Science F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The course covers four major topics. 1. The thermodynamic properties of interfaces (surface energy, wetting, surface area and porosity, capillary effects, work of adhesion/cohesion). 2. Models of adsorption/desorption phenomena. 3. The amphiphilic behaviour of surfactants. 4. The stability and characterization of colloidal systems. Student appreciation for the importance of these phenomena is cultivated using examples drawn from industrial processes/products including inks, paints, foods, polymer blends, and nanocomposites.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0

PREREQUISITE(S): CHEE 210 or permission of the department.
EXCLUSION(S): CHEM 347

CHEE 463 Electrochemical Energy Systems W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This engineering science and design course examines and analyzes electrochemical energy generation, conversion and storage technologies of emerging importance to modern society. Methods of generating electrical power will be examined in terms of efficiency, cost, environmental footprint, greenhouse gas emissions and current and potential applications. Integration of these power generation systems with energy conversion and storage technologies will be assessed in terms of their compatibility with the supply and demand model of the electricity grid and their potential for use in remote off-grid communities. The electrification of transportation technologies will also be examined. The design element of this course involves hands-on prototyping of an integrated energy system for a specified application.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 28
Engineering Design 14

PREREQUISITE(S): CHEE 363

CHEE 470 DELETED - Design of Manufacturing Processes F | K 7

Lecture: yes
Lab: no
Tutorial: yes
This course will consolidate the necessary skills and knowledge for a working chemical engineer by carrying out an industrial process design and developing a Front End Engineering Design (FEED) document. The students will develop proficiency in the following: Process selection and synthesis, the use and recognition of the limitations of process simulation software, development of Piping and Instrumentation diagrams, analysis of process safety, equipment sizing, materials selection, and economic analysis, including the estimation of capital and operating cost along with optimization. Nov. 2020

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 84

PREREQUISITE(S): CHEE 331, CHEE 361, CHEE 321, or permission of the Department.

CHEE 471 Chemical Process Design FW | 7

Lecture: Y
Lab: N
Tutorial: Y
This capstone course integrates skills, knowledge and experience gained from engineering science components of the Chemical Engineering and Engineering Chemistry curriculum to solve open-ended chemical process design problems. Students will develop competency in the following: process hazard analysis, appropriate use of process simulation techniques, identification and mitigation of process inefficiencies and risks, strategies for acquiring technical data, and cost estimation of process revisions.

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 84

PREREQUISITE(S): CHEE 321, CHEE 331, CHEE 361, or permission of the Instructor.

CHEE 481 DELETED - Air Quality Management W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Fluid-particle systems and mass transfer principles are presented with application to air pollution control in industrial processes. The selection and design of equipment for the control of particulate and gaseous emission sources are examined. The problem of odorous emissions, stack sampling techniques and dispersion calculations are discussed. No

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 18

PREREQUISITE(S): One of CHEE 223, CIVL 250, or MECH 241, or permission of the department

CHEE 484 NOT OFFERED 2021-2022 Bioremediation W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Bioremediation as an option to treat contaminated soils and ground water. Advantages and disadvantages of bioremediation compared to nonbiological processes. Factors affecting choice of in situ or ex situ processes. Assessment of biodegradability; biostimulation vs bioaugmentation; mineralization vs. partial degradation; factors affecting microbial activity (choice of electron acceptor, toxicity of pollutant, C/N/P ratio, co-substrates, soil humidity, pH and temperature); bioavailability of pollutant. Biodegradation of specific contaminants (e.g. diesel fuel, polychlorinated biphenyls, dyestuffs, aromatic and polyaromatic hydrocarbons) will be studied in detail. The design component of this course consists of learning design of appropriate laboratory and field experiments to obtain data on microbial degradation of an organic pollutant to be able to calculate bioremediation design parameters such as mass and delivery rate requirements of electron acceptors and nutrients and degradation rates in reactor and non-reactor based systems;

and to be aware of limitations of these calculations.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

CHEE 490 Polymer Formulations and Processing Technology W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The design and manufacture of polymer products is reviewed, with particular emphasis on material selection and processing technology. The engineering properties of elastomers, thermoplastics, adhesives, fibres and coatings are discussed in terms of processing characteristics and end-use performance. Industrial processing operations such as extrusion, molding, mixing and film manufacture are presented in detail. The design component of the course requires students to select appropriate materials and processing methods for an engineering application. Examples include medical catheters, engine gaskets, drug capsules and biodegradable packaging.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): CHEE 223 or MECH 241, or permission of the department

MICR 360 Immunology F | 3

Lecture: 3
Lab: 0
Tutorial: 0
The general principles and mechanism of immune reaction. Immunochemical and immunobiological aspects of antibody formation and cell-mediated immunity in health and disease will be considered.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0

Engineering Science 0
Engineering Design 0

COREQUISITE(S): BCHM 310 or BCHM 315 or BIOL 334 or equivalents or permission of the department.

Civil Engineering

CIVL 200 Professional Skills I F | 2.5

Lecture: 0
Lab: 0
Tutorial: 0
This intensive short-course serves as a kickoff to Civil Engineering at Queen's. Students will be engaged in a design challenge where they are to conceive, design, implement and operate a system to achieve some specified function bounded by constraints. Focus will be placed on development of decision making, team building, communication and engineering design skills.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 8
Engineering Science 0
Engineering Design 20

CIVL 201 Professional Skills F/W | 2.5

Lecture: 0.5
Lab: 1
Tutorial: 1
Within a team structure potentially involving second, third, and fourth year Civil Engineering students and a faculty advisor, students will engage in a range of exercises designed to promote written and verbal communication, decision making, team building and engineering design skills. Lectures, workshops, design charettes and both individual and team assignments will be utilized to enhance learning. This course is available only to select students, under exceptional or extenuating circumstances, at the discretion of the Head of the Department and the Undergraduate Chair. (This course may not be offered every year).

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 14
Engineering Science 7
Engineering Design 7

PREREQUISITE(S): Permission of the Department
EXCLUSION(S): CIVL 200

CIVL 210 Chemistry for Civil Engineers F | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
Application of fundamental chemistry principles with respect to their sources, reactions, effects and fates in civil and environmental engineering systems. Topics will include chemical equilibria, stoichiometry and reaction kinetics; electrochemistry and corrosion; adsorption and ion exchange; solubility and precipitation; coagulation; microbiological reactions and kinetics; biochemical, chemical and theoretical oxygen demand; acidity, alkalinity and hardness; as well as biogeochemical cycles. These concepts will be further developed and applied in tutorial and laboratory modules. A design-based laboratory is conducted as part of this course. Personal Protective Equipment (PPE) will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 20
Complementary Studies 0
Engineering Science 20
Engineering Design 15

PREREQUISITE(S): APSC 132

CIVL 215 Materials for Civil Engineers W | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
The basic engineering properties, micro/macro structure, behaviour and applications of various civil engineering materials will be studied including materials used in structural engineering, hydrotechnincal engineering, geotechnical engineering and environmental engineering. This will include concrete, steel, timber, polymers, composites and soil. Interaction between materials will be examined. Laboratory experiments will be used to demonstrate material behaviour. PPE will be required for this course student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0

Engineering Science 32
Engineering Design 10

PREREQUISITE(S): APSC 151

CIVL 220 Deleted - Statics and Solid Mechanics F | 4

Lecture: 3
Lab: 0.25
Tutorial: 0.75
Review of statics, forces and equilibrium, internal forces in simple structures; axial, torsion, shear and moment diagrams; concepts of stress and strain; mechanical properties of materials; centroids and moments of areas; axial stress; flexural stress; shear stress in shafts and beams; calculation of displacement by integration; introduction to combined loading; introduction to column buckling. This course is designed primarily for mechanical engineering students.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 48
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 171. Permission of the department for students not registered in Mechanical Engine

CIVL 222 Numerical Methods for Civil Engineers W | 5

Lecture: 4
Lab: 1
Tutorial: 0
This course introduces the basics of numerical analysis and the use of computer software (MATLAB) for civil engineering analysis. Error analysis, numerical differentiation and integration, root finding, derivation and numerical solution of partial differential equations using finite difference methods, and optimization are among the topics covered. All problems emphasize engineering applications.

Academic Units:
Mathematics 45
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 0

PREREQUISITE(S): MTHE 224 (MATH 224) or MTHE 225 (MATH 225) or MTHE 226 (MATH 226)

CIVL 230 Solid Mechanics I F | 4.25

Lecture: 3
Lab: 0.5
Tutorial: 0.75
Graphic Statics; Definitions of Stress and Strain; Hooke's Law; "Axial" Member Analysis and Design; Analysis and Design of Shafts Subjected to Torsion; Analysis and Design of Beams; Columns; Inelastic Bending; Introduction to Work and Energy and the Principle of Virtual Work

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 50
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 171, APSC 182
EXCLUSION(S): MECH 221

CIVL 231 Solid Mechanics II W | 4.5

Lecture: 3
Lab: 0.5
Tutorial: 1
Shear and bending moment diagrams; Moment-area method; Introduction to statically indeterminate structures; Virtual work for beams and frames (determinate and indeterminate); Stress review, transformed sections, and combined loading; Stress-strain transformation (including Mohr's circle); Failure theories.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 54
Engineering Design 0

PREREQUISITE(S): CIVL 230

CIVL 250 Hydraulics I W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Fluid properties, fluid statics, basic equations of fluid flow: Continuity, Momentum, Euler's Equation of Motion, Linear Momentum Equation and Bernoulli's Equation. Flow of real fluid in closed conduits: friction losses and local energy losses. Pipeline flows in engineering practice. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 4
Complementary Studies 0
Engineering Science 22
Engineering Design 22

PREREQUISITE(S): APSC 172, APSC 174

CIVL 260 Deleted - Civil Engineering Design I F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
The objectives of this introductory course are: to introduce students to engineering design and the challenges and excitement of the civil engineering profession; to develop written and oral communications skills; to develop an appreciation and ability for teamwork, creativity and time/project management; to develop skills in idea generation, creative problem solving, and research; and to develop skills in using computer applications in engineering design and analysis. The course exposes students to civil engineering design through case studies and group projects. Students are expected to learn about the design process through practice and, where possible, through implementation. Design projects are team-based and as such students need to learn how to work effectively with their peers. Sketching and AutoCAD are also be introduced and used. The design principles and concepts introduced will be used in follow-on courses throughout students' degrees. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 12
Engineering Design 24

CIVL 300 Professional Skills II F | K 2.5

Lecture: 0.5
Lab: 1
Tutorial: 1
Professional skills relating to how engineers interact with, communicate with, and consider the implications of their actions on a wide range of potential stakeholders, ranging from colleagues to clients to society as a whole, will be developed. Students will improve their technical writing and verbal communication skills as they work through case studies intended to: deepen an understanding of the roles and responsibilities of a Professional Engineer; strengthen an ability to apply professional ethics, accountability and equity; and enhance an appreciation of the potential social and environmental impacts of engineering activities. Class discussions will normally occur every second week.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): CIVL 200

CIVL 330 Structural Analysis F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
Analysis of statically determinate structures such as trusses and plane frames, calculation of deflections by virtual work. Flexibility and stiffness methods for analyzing statically indeterminate structures. Computer applications of the above methods.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 44
Engineering Design 0

PREREQUISITE(S): CIVL 230, CIVL 231

CIVL 331 Structural Steel Design W | 4

Lecture: 3
Lab: 0
Tutorial: 1

Introduction to Limit States Design, load paths. Dead and live loads for design as specified in the National Building Code of Canada. Design assumptions regarding material properties of structural steel. Design of tension members; bolted connections; design of simple columns; design of beams (laterally supported and laterally unsupported) for flexure and shear; design of bearing stiffeners; design of steel-concrete composite beams; stability analysis; design of beam-columns. Sustainability for building materials; introduction to LEED.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 36

PREREQUISITE(S): CIVL 330

CIVL 340 Geotechnical Engineering I F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
An introductory course focussing on the fundamental mechanics of soil materials (gravel, sand, silt and clay) applied to geotechnical engineering problems. Topics studied include: phase relationships; index properties of coarse and fine grained soils; one-dimensional steady state seepage; effective stress; one-dimensional compression and consolidation; drained and undrained shear strength; and lateral earth pressure. Theoretical material is applied to examine real engineering issues with a particular focus on developing design skills and engineering judgement. Students will conduct physical experiments to explore soil behaviour. The important role of geology on the mechanics of geotechnical materials is emphasized through classroom discussions and problem sets. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 32
Engineering Design 12

PREREQUISITE(S): CIVL 215 or GEOE 281 (GEOL 281), CIVL 230

CIVL 341 Geotechnical Engineering II W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
A course focusing on design issues and methods of analysis for practical geotechnical engineering problems. Topics studied include: site investigation; capacity and settlement of shallow and deep foundations; two-dimensional steady state seepage; landslides and slope stability. Commercial software will be introduced to perform stability, deformation and seepage analyses. Students will conduct physical experiments to explore how design methods compare with real soil behaviour. The important role of geology in geotechnical design is emphasized through classroom discussions and problem sets. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 36

PREREQUISITE(S): CIVL 340

CIVL 350 Hydraulics II F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
Topics in open channel flow including friction, specific energy, free-surface profiles, culverts and hydraulic-jump energy dissipaters. Lake dynamics and environmental hydraulics will be introduced. The basic underlying concepts of water resources and hydrology will be discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 30

PREREQUISITE(S): CIVL 250

CIVL 360 Civil Engineering Design and Practice III W | K4

Lecture: Yes
Lab: No
Tutorial: Yes

Students will develop and employ Engineering Design and Practice skills to resolve a complex, open-ended design task. This will involve the iterative application of Civil Engineering technical knowledge to identify and evaluate design options. The economic, environmental and societal implications of the preferred solution(s) will be assessed. Students will select, detail and communicate their final design in a logical, traceable and defendable manner. Ethical, legal and other relevant professional issues will be studied and discussed through case studies. Students will also develop and enhance written, graphical and oral communications skills.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Design 36

PREREQUISITE(S): APSC 200

CIVL 370 Deleted - Fundamentals of Environmental Engineering |

This course provides an introduction to the science and engineering of environmental issues and problems, with the main goal being the protection of the health and well-being of humans and their surroundings. Topics may include an examination of human-induced environmental problems, and the role of technology in dealing with these; the scientific aspects of environmental engineering which are used to quantify and qualify environmental problems; and the technological control of environmental problems. Health and safety issues relating to human and ecosystem exposure to environmental contaminants are emphasized, and local and global examples of environmental problems and solutions are used. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 32
Engineering Design 16

PREREQUISITE(S): CIVL 210, or ENCH 211 (CHEM 211)

CIVL 371 Groundwater Engineering F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
This course introduces students to the fundamentals of groundwater systems with an emphasis on the engineering design of extraction systems for water supply, site dewatering, and parameter estimation tests. Source water protection methods will be discussed. Equations governing the

flow of groundwater, flownets, and capture zones are presented. Detailed case histories are presented. Laboratories make extensive use of commercial grade software for surface and groundwater flow simulation.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 14

PREREQUISITE(S): MTHE 224 or MTHE 225 or MTHE 232

CIVL 372 Water and Wastewater Engineering W | 4

Lecture: 3
Lab: 1
Tutorial: 0
The focus of this course is to introduce water and wastewater engineering systems through active learning strategies and hands-on lab experiences. Students will have the opportunity to learn about environmental indicators/measurements/guidelines, reactors, engineered and natural systems, biological and chemical reactions, mass and energy balances, risk assessment, life cycle assessment, and environmental and human health impact assessment. These concepts will allow students to assess a variety of aspects of environmental engineering and design.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 20
Engineering Design 16

PREREQUISITE(S): CIVL 210

CIVL 380 Deleted - Applied Sustainability and Public Health in Civil Engineering |

This course introduces concepts and tools to undertake the sustainable design of infrastructure systems. Emphasis is placed on the prevention of environmental and human health damage at the design stage of civil engineering systems. Key concepts of sustainability, natural capital, humanmade capital are defined. The rules of "weak" and "strong" sustainability are introduced. Life-cycle analysis, environmental input-output analysis, and quantitative risk assessment are introduced as systems-level approaches and applied to material selection and design decisions of civil engineering systems. Students will apply these techniques in a design project. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): CIVL 215, CIVL 250, or permission of the Department

CIVL 400 Professional Skills III F | 2.5

Lecture: 0.5
Lab: 1
Tutorial: 1
Professional skills relating to how engineers interact with, communicate with, and consider the implications of their actions on a wide range of potential stakeholders, ranging from colleagues to clients to society as a whole, will be developed. Students will improve their technical writing and verbal communication skills as they work through case studies intended to: deepen an understanding of the roles and responsibilities of a Professional Engineer; strengthen an ability to apply professional ethics, accountability and equity; and enhance an appreciation of the potential social and environmental impacts of engineering activities. Class discussions will normally occur every second week.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): CIVL 300
COREQUISITE(S): CIVL 460

CIVL 409 Deleted - Engineering Report F | 3.5

Lecture: 0.5
Lab: 0
Tutorial: 3
The primary purpose of this course is to provide students with the opportunity to write and present an engineering report, a task they will often have to fulfil during their careers as practicing engineers. The exact nature of these reports varies, but may include proposals, assessments, feasibility studies, evaluations and specifications and communication of results. Since the student will not be expected to have at hand all information normally available to the

practicing engineer, it is expected that the report will take one of the following forms: a critical review and discussion of the literature on an engineering problem; a report on an engineering project on which the student has worked; or a report on an experimental undertaking. A number of drafts of the report will be submitted according to a fixed time schedule, before the final version is ready for publication. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 30
Engineering Science 5
Engineering Design 5

PREREQUISITE(S): CIVL 204

CIVL 430 Reinforced Concrete Design F | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
Flexural design of reinforced concrete beams including singly reinforced sections, doubly reinforced sections, T-sections, and one-way slabs. Control of cracking in reinforced concrete beams as specified for design. Design of continuous beams and one-way slabs; short and slender columns; footings deflections; development of reinforcement. A laboratory design project is undertaken in this course. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 33

PREREQUISITE(S): CIVL 215, CIVL 330, CIVL 331

CIVL 431 Infrastructure Rehabilitation W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
This course deals with evaluation of the deterioration of the infrastructure and the design of rehabilitation measures. Items discussed include corrosion of reinforcement in concrete, microbiological corrosion of buried pipelines, asphalt deterioration and repair, deterioration of

timber in buildings, and issues of sustainability of infrastructure. Design techniques to reduce deterioration in new construction are also discussed. The laboratory portion involves some of the test methods used to evaluate deterioration and field trips to observe some common forms of deterioration. PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 32
Engineering Design 16

PREREQUISITE(S): CIVL 430

CIVL 436 Prestressed Concrete W | 4

Lecture: 3
Lab: 0
Tutorial: 1
Behaviour, analysis and design of pretensioned and post-tensioned concrete systems including simply-supported and continuous beams, and two-way slabs. Considerations of prestress losses, cracking and deflection. A design project is undertaken in this course. Three term-hours, winter; lectures and tutorials.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24

PREREQUISITE(S): CIVL 430

CIVL 442 Geotechnical Design F | 3.75

Lecture: 3
Lab: 0
Tutorial: 0.75
A design-based course where geotechnical principles are applied to study the design of a variety of geotechnical engineering structures. Topics studied include: design of a site investigation program, interpretation of site stratigraphy, estimation of soil parameters, design of shallow and/or deep foundations, design of earth retaining structures, and construction issues such as dewatering schemes or temporary excavations. Students will conduct practical design tasks to

experience a range of aspects of the geotechnical design process, to utilize common models used in geotechnical design, and to communicate with project partners such as structural consultants, site investigation companies, and construction contractors. The important role of geology in geotechnical problems is emphasized through classroom discussions, planning a site investigation and constructing a geologic model.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 10
Engineering Design 35

PREREQUISITE(S): CIVL 341

CIVL 443 Geoenvironmental Design W | 4

Lecture: 3
Lab: 1
Tutorial: 0
A design-based course where geotechnical and hydrogeologic principles are applied to study environmentally sustainable disposal of solid waste. Topics studied include: source and nature of waste: disposal options; environmental legislation and regulations; public impact and perception; contaminant transport; use of geosynthetic materials; and design issues and tradeoffs. Students will conduct practical design tasks to investigate the planning, design, construction, operation and post-closure of phases of an engineered waste disposal facility. The important role of geology in geoenvironmental problems is emphasized through classroom discussions, planning a site investigation and constructing a geologic model.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 36

PREREQUISITE(S): CIVL 340 or permission of the department

CIVL 450 Municipal Hydraulics F | 3.75

Lecture: 3
Lab: 0
Tutorial: 3
The course will present concepts and tools to analyze and design water services, including storm

sewers, sanitary sewers, and water mains, at the site- and sub-division level. Many of the concepts and tools are used in the fields of land-development engineering and municipal engineering. The course will provide an interoduction to hydrological processes, design rainfall prediction with intensity-duration-frequency curves, estimation of time of concentration, peak runoff prediction in small drainage areas with the Rational Method and the unit hydrograph method, reservoir routing and storm water management tank and pond design, storm sewer analysis and design with Manning's equation, wastewater flow prediction, sanitary sewer analysis and design, water demand prediction, steady-state analysis of pressurized pipes, water main design, and designing water services according to municipal design standards.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 12

PREREQUISITE(S): CIVL 350

CIVL 451 Lake, Reservoir and Coastal Engineering F | 3.75

Lecture: 3
Lab: 0.5
Tutorial: 0.25
The fundamental hydraulic processes affecting coastal engineering and water reservoir operation are discussed. Topics include wave theory, wave measurement, wave record analysis, wave transformation, seiches, tides, storm surges, turbulent mixing and transport of pollutants. Student projects are assigned on computational water reservoir modelling, analysis of field data and reservoir operation as well as the design of breakwaters and ocean structures and the use of hydraulic and numerical coastal models.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 22
Engineering Design 22

PREREQUISITE(S): CIVL 350, or permission of the department

CIVL 455 River Engineering F | 4

Lecture: 3
Lab: 0.5

Tutorial: 0.5
A course in the basics of river engineering including the study of alluvial processes, the prediction and consequences of sediment transport, the design of measures to control erosion and accretion, and the design of dams, spillways and diversions. Cristical aspects in the design of river engineering structures and assessment of environment impact of river engineering projects are discussed. The use of physical and numerical models in the practice of river engineering is illustrated. The principles of natural channel design, stream restoration, and bioengineering in river environments are also addressed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24

PREREQUISITE(S): CIVL 350

CIVL 460 Civil Engineering Design and Practice IV FW | K6

Lecture: Yes
Lab: No
Tutorial: Yes
This fourth year design capstone course has student teams undertake a comprehensive engineering design project which involves the creative, interactive process of designing a structure/system to meet a specified need subject to economic, health, safety and environmental constraints. The teams will work in collaboration with an industry partner. Each team will submit an engineering report and make an oral presentation PPE will be required for this course at student's cost (see course materials for details)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 60

PREREQUISITE(S): APSC 200, APSC 293, CIVL 360, CIVL 330, CIVL 340, CIVL 350, CIVL 371 or in final 16 months of CIVL program.

CIVL 470 Deleted - Municipal Water Engineering |

Continuing from the introductory material in CIVL 370, this course describes the engineering aspects of the provision of potable water, and the collection, treatment and disposal of wastewater in the urban environment. Topics include the quality of water supplies and the characteristics of wastewater; estimation of water consumption and sewage generation; the chemical and physical treatment of water for drinking purposes; design of water distribution and wastewater collection systems; physical, chemical and biological wastewater treatment; and effluent and sludge disposal. Alternative urban development strategies are discussed (i.e. water conservation and urban reuse). The laboratories illustrate basic analytical methods which provide data for design of these systems. PPE will be required for this course at student's cost (see course materials for details) - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 16
Engineering Design 16

PREREQUISITE(S): CIVL 370, or permission of the department

CIVL 471 Subsurface Contamination F | 4

Lecture: 3
Lab: 0
Tutorial: 1
This course deals with subsurface contamination by hazardous industrial liquids such as PCB oils, gasoline, jet fuel, chlorinated solvents and coal tars. The fundamentals of multiphase/multicomponent flow and transport in soil and groundwater are outlined followed by specific treatment of both dense and light non-aqueous phase liquids. The course will examine the subsurface distribution of these liquids, site characterization methods, indoor air intrusion, regulatory apsects, remediation technologies, and selected case histories.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 34
Engineering Design 14

PREREQUISITE(S): CIVL 371, or GEOE 343 (GEOL 343), or permission of the department

CIVL 472 Water Treatment W | 3.75

Lecture: 3
Lab: 1
Tutorial: 0.5

This course describes the physical-chemical treatment processes for water treatment. Students in this course will learn about the chemical and microbiological constituents in source water that determine downstream treatment requirements. Students will explore the fundamental physical, chemical and biological principles that govern unit operations (e.g. coagulation and flocculation; screening, sedimentation, and floatation; filtration; disinfection) and their applications in water treatment plants. Students will learn about plant optimization and apply systems thinking to analyze and design water treatment scenarios. The responsibilities of a professional engineer in ensuring safe drinking water will also be discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 33
Engineering Design 11

PREREQUISITE(S): CIVL 372

CIVL 473 Water Resources System W | 3.75

Lecture: 3
Lab: 0
Tutorial: .75
This course will present concepts and tools for designing and modelling large-scale water resources systems in urban catchments. Focus will be placed on the design and analysis of urban drainage systems and urban water supply/distribution systems at the catchment level. Hydrologic, hydraulic, and statistical modelling tools used in industry will be used to evaluate the performance of water resources systems. Topics will include: the urban water cycle, environmental considerations in master planning of drainage and water supply systems, climate change impacts on water resources systems, floodplain analysis and flood control, statistical analysis of rainfall and stochastic hydrology, continuous simulation modelling, planning and modelling of large-scale urban drainage systems, planning and modelling of large-scale water distribution systems, reliability analysis and water quality analysis of water distribution systems, and the master planning process for urban drainage and drinking water systems.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 12

PREREQUISITE(S): CIVL 350

CIVL 490 Selected Topics in Civil Engineering F | 3.75

Lecture: 3
Lab: 0
Tutorial: 0.75
Providing advanced study and application of selected topics in Civil Engineering, this course will be offered periodically by visiting faculty and professionals. Consult the department homepage for opportunities.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 45
Engineering Design 0

PREREQUISITE(S): Successful completion of 3rd year Civil Engineering and permission of the Department.

CIVL 491 Selected Topics in Civil Engineering W | 3.75

Lecture: 3
Lab: 0
Tutorial: 0.75
Providing advanced study and application of selected topics in Civil Engineering, this course will be offered periodically by visiting faculty and professionals. Consult the department homepage for opportunities.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 45
Engineering Design 0

PREREQUISITE(S): Successful completion of 3rd year Civil Engineering and permission of the Department.

CIVL 500 Civil Engineering Thesis FW | K4

Lecture: Yes
Lab: Yes
Tutorial: Yes
Working closely with a faculty member, students will conduct research on a civil engineering or

related applied science topic. Students will: identify a problem; formulate a research question; and devise and implement a research plan. The nature of the research may involve obtaining experimental measurements, performing field testing and/or numerical analysis, and analyzing and interpreting research results. Students will prepare a comprehensive, written technical report and will defend their research in an oral examination. Registration is limited to a maximum of twenty (20) students PPE will be required for this course at student's cost (see course materials for details).

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 24
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): successful completion of 3rd year civil engineering with a minimum sessional average of 70%

Computer Engineering

CMPE 204 Logic for Computing Science F/W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Elements of mathematical logic with computing applications. Formal proof systems for propositional and predicate logic. Interpretations, validity, and satisfiability. Introduction to soundness, completeness and decidability.

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ELEC 270 or CISC 203

CMPE 212 Introduction to Computing Science II F/W | 4

Lecture: 3
Lab: 1
Tutorial: 0
Introduction to object-oriented design, architecture, and programming. Use of packages, class

libraries, and interfaces. Encapsulation and representational abstraction. Inheritance. Polymorphic programming. Exception handling. Iterators. Introduction to a class design notation. Applications in various areas.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 22

PREREQUISITE(S): APSC 142 or APSC 143 or MNTC 313, ELEC 278
EXCLUSION(S): CISC 124

CMPE 223 Software Specifications W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to techniques for specifying the behaviour of software, with applications of these techniques to design, verification and construction of software. Logic-based techniques such as loop invariants and class invariants. Automata and grammar-based techniques, with applications to scanners, parsers, user-interface dialogs and embedded systems. Computability issues in software specifications.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): ELEC 278, ELEC 270

CMPE 251 Data Analytics F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to data analytics; data preparation; assessing performance; prediction methods such as decision trees, random forests, support vector machines, neural networks and rules; ensemble methods such as bagging and boosting; clustering techniques such as expectation-maximization, matrix decompositions, and biclustering; attribute selection.

Academic Units:
Mathematics 10
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 12

PREREQUISITE(S): APSC 142 or APSC 143 or MNTC 313, or programming experience recommended
EXCLUSION(S): CISC 251, CMPE 333, CISC 333

CMPE 271 DELETED - Scientific Computing W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to scientific computing: floating point arithmetic, algorithm design, error analysis, ill-conditioning. Zero-finding. Linear equations. Interpolation. Integration. Least-squares fitting. Effective use of library programs, with discussion of their limitations and some aspects of their design and implementation. Nov. 2019

Academic Units:
Mathematics 21
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 0

PREREQUISITE(S): APSC 142, APSC 172, APSC 174
EXCLUSION(S): ENPH 213

CMPE 320 Fundamentals of Software Development F | 4

Lecture: 3
Lab: 0
Tutorial: 1
Introduction to management of small and medium-scale software projects. Advanced programming methodology using the programming language C++. Includes a significant programming project.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0

Engineering Science 26
Engineering Design 22

PREREQUISITE(S): ELEC 278

CMPE 322 Software Architecture W | 4

Lecture: 3
Lab: 0
Tutorial: 1
Abstractions and patterns of interactions and relationships among modules. Design recovery; relationship of architecture to requirements and testing.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 22
Engineering Design 26

PREREQUISITE(S): ELEC 270, CMPE 223 (CISC 223), ELEC 278

CMPE 324 Operating Systems W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Layered operating systems for conventional shared memory computers: Concurrent processes, Synchronization and communication, Concurrent algorithms, Scheduling Deadlock, Memory management, Protection. File systems. Device management. Typical layers.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 0

PREREQUISITE(S): ELEC 274, ELEC 278
EXCLUSION(S): ELEC 377

CMPE 325 Human-Computer Interaction W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Developing usable software requires that human factors be considered throughout the design and development process. This course introduces a series of techniques for development and evaluating usable software, and shows how these techniques can be integrated into a process for software development. Alternately offered as CISC 325.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): ELEC 278

CMPE 326 Game Architecture DELETED F | 4

Lecture: 3
Lab: 0
Tutorial: 1
An introduction to software architectural design through the application domain of game development. Topics will include notations for expressing static and dynamic aspects of software architecture, design patterns, interface design, and application of these techniques to 3D games, mobile games and web-based games. Jan 2018

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 22

PREREQUISITE(S): ELEC 270, ELEC 278, ELEC 377
EXCLUSION(S): CMPE 322

CMPE 327 Software Quality Assurance F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Validation of software throughout the life cycle. Comparative effectiveness in defect removal of formal methods (proofs of correctness), inspection (walkthroughs and reviews), and testing (unit,

integration, and system testing; white box versus black box).

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): ELEC 279 or CMPE 212

CMPE 330 Computer-Integrated Surgery F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Concepts of computer-integrated surgery systems and underlying techniques such as medical-image computing, robotics, and virtual reality, learned through real-life applications and problems. Techniques learned in class will be applied in a hands-on surgery session where students perform minimally invasive surgery with virtual-reality navigation tools. Enrolment is limited.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 0

PREREQUISITE(S): ELEC 279 or CMPE 212, MTHE 272 or ELEC 273 or ELEC 372

CMPE 332 Database Management Systems W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Data models: relational, entity-relationship. Relational query languages: relational algebra and SQL. Relational database design. Application interfaces and embedded SQL. Storage and indexing.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0

Engineering Science 24
Engineering Design 12

PREREQUISITE(S): ELEC 278, ELEC 270 or MTHE 217 (MATH 217)

CMPE 333 DELETED Data Analytics F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to data analytics; data preparation; assessing performance; prediction methods such as decision trees, random forests, support vector machines, neural networks and rules; ensemble methods such as bagging and boosting; clustering techniques such as expectation-maximization, matrix decompositions, and biclustering; attribute selection. Deleted Jan. 2019

Academic Units:
Mathematics 10
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 12

PREREQUISITE(S): APSC 142 or APSC 143, or programming experience recommended.
EXCLUSION(S): CISC 251, CISC 333

CMPE 351 Advanced Data Analytics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Design and implementation of complex analytics techniques; predictive algorithms at scale; deep learning; clustering at scale; advanced matrix decompositions, analytics in the Web, collaborative filtering; social network analysis; applications in specialized domains.

Academic Units:
Mathematics 10
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 12

PREREQUISITE(S): CMPE 251, ELEC 326 or MTHE 351
EXCLUSION(S): CISC 351, CISC 372

CMPE 365 Algorithms I F | 4

Lecture: 3
Lab: 1
Tutorial: 0
Principles of design, analysis and implementation of efficient algorithms. Case studies from a variety of areas illustrate divide and conquer methods, the greedy approach, branch and bound algorithms and dynamic programming.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24

PREREQUISITE(S): ELEC 278, ELEC 270 or any discrete mathematics course

CMPE 422 Formal Methods in Software Engineering F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Mathematical methods for describing software behaviour and structure. Topics include (but are not limited to) the following: requirements specification; Module specification: axiomatic, algebraic, and trace specification; program specification: abstract models; verification; specification-based validation.

Academic Units:
Mathematics 14
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 10

PREREQUISITE(S): CMPE 204 (CISC 204), CMPE 223 (CISC 223)

CMPE 425 NOT OFFERED 2021-2022 Advanced User Interface Design W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Advanced user interface styles such as multimedia, support for collaboration over the Internet, virtual reality and wearable computers. Processes supporting the design of advanced user

interfaces. Implementation techniques. Alternately offered as CISC 425.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): CMPE 325 or permission of the instructor

CMPE 432 NOT OFFERED 2021-2022 Advanced Database Systems F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Topics include the presentation and storage of data, implementation concerns, and the integration of databases with other areas of computer science.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): CMPE 332 (CISC 332), ELEC 278

CMPE 434 NOT OFFERED 2021-2022 Distributed Systems F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Operating systems for distributed architectures: distributed system characteristics, process synchronization and communication. Basic distributed algorithms. Principles of fault tolerance. Reliable broadcast. Naming. File systems. Load balancing. Layering, Security.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): ELEC 377

CMPE 452 Neural Networks and Genetic Algorithms F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Artificial Neural Networks (ANN) and Genetic Algorithms (GA) for problem solving and prediction tasks such as classification, clustering, optimization and data reduction and modeling human cognition, with application to real world problems. Ongoing research in this area in various application domains.

Academic Units:
Mathematics 9
Natural Sciences 15
Complementary Studies 0
Engineering Science 12
Engineering Design 0

PREREQUISITE(S): ELEC 278, or permission of the instructor
EXCLUSION(S): ELEC 425

CMPE 454 Computer Graphics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
An introduction to computer graphics, including a review of current hardware; modelling and transformations in two and three dimensions; visual realism; perspective, hidden surface elimination, and shading; colour models; applications in several fields.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): ELEC 278

CMPE 457 Image Processing and Computer Vision F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Fundamental concepts and applications in image processing and computer vision. Topics include image acquisition, convolution. Discrete Fourier Transform, image enhancement edge detection, segmentation, image registration, human contrast perception, colour perception and reproduction, and stereo vision.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): Any first-year algebra course, any first-year calculus course, ELEC 278
EXCLUSION(S): ELEC 474

CMPE 458 Programming Language Processors W | 4

Lecture: 3
Lab: 0
Tutorial: 1
Introduction to the systematic construction of a compiler: grammars and languages, scanners, top-down and bottom-up parsing, runtime organization, symbol tables, internal representations; Polish notation, syntax trees, semantic routines, storage allocation, code generation, interpreters.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 18

PREREQUISITE(S): ELEC 279 or CISC 121 or CMPE 212 and ELEC 274

CMPE 471 Computational Biology F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to computational approaches to the problems in molecular biology. This will include the study of areas such as techniques and algorithms for sequence analysis and alignment; molecular databases; protein structure prediction and molecular data mining.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Science 9
Engineering Design 9

PREREQUISITE(S): CMPE 365 (CISC 365), OR ELEC 278, MBIO 218
COREQUISITE(S): BCHM 315

CMPE 472 Medical Informatics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Current topics in the application of information technology to medicine, including computed tomography and x-ray imaging: 2D and 3D ultrasound; computer-assisted planning of interventional procedures; image registration; computer-assisted surgery; bioelectric signals; picture archiving and communication systems (PACS).

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): CMPE 330

CMPE 480 Deleted - Computational Biology Laboratory W | K 1

Lecture: No
Lab: Yes
Tutorial: No
Laboratory in the use of advanced computational approaches to the problems in molecular biology. COURSE DELETED 2017-2018

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 9
Engineering Design 3

PREREQUISITE(S): CMPE 365 , (CISC 365), or ELEC 278 , MBIO 218
COREQUISITE(S): CMPE 471 , BCHM 315

Electrical Engineering

ELEC 210 DELETED Introductory Electric Circuits and Machines W | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
An introductory course for engineering students in disciplines other than electrical or computer engineering. The course begins with a review of the concepts of resistance, capacitance, and inductance. Circuit analysis techniques are then applied to characterize the behaviour of commonly used electrical energy conversion devices such as transformers, dc machines, and induction and synchronous machines. Jan 2019

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 51
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 112, APSC 171, APSC 172, APSC 174

ELEC 221 Electric Circuits F | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
This course introduces the circuit analysis techniques which are used in subsequent courses in electronics, power, and signals and systems. Circuits containing resistance, capacitance, inductance, and independent and dependent voltage and current sources will be studied. Emphasis is placed on DC, AC, and transient analysis techniques.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 38
Engineering Design 13

PREREQUISITE(S): APSC 112 or APSC 114, APSC 171, APSC 172, APSC 174
COREQUISITE(S): MTHE 235 or MTHE 237 or MTHE 225 or MTHE 232

ELEC 224 Continuous-Time Signals and Systems W | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
This is a first course on the basic concepts and applications of signals and systems analysis. Continuous time signals and systems are emphasized. Topics include: representations of continuous-time signals; linear time invariant systems; convolution, impulse response, step response; review of Laplace transforms with applications to circuit and system analysis; transfer function; frequency response and Bode plots; filtering concepts; Fourier series and Fourier transforms; signal spectra; AM modulation and demodulation; introduction to angle modulation.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 33
Engineering Design 0

PREREQUISITE(S): ELEC 221, MTHE 235 (MATH 235) or MTHE 237 (MATH 237)
EXCLUSION(S): ELEC 323

ELEC 252 Electronics I W | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
This course is an introduction to semiconductor electronics for students in the Electrical Engineering program and related programs. Topics studied include: operational amplifiers; dc and small signal models for diodes, basic principles of bipolar transistors and field effect transistors, dc analysis of electronic circuits and practical applications of the devices to the design of power supplies, amplifiers and digital logic circuits.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 15

PREREQUISITE(S): ELEC 221

ELEC 270 Discrete Mathematics with Computer Engineering Applications W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction to the mathematics of representing and manipulating discrete objects. Topics include numbers, modular arithmetic, counting, relations and graph theory. Methods of proof and reasoning - such as induction and mathematical logic - will also be covered. Some applications to cryptosystems, hashing functions, job scheduling, and coding will be included.

Academic Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): APSC 142 or APSC 143 or MNTC 313

ELEC 271 Digital Systems F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Boolean algebra applied to digital systems; logic gates; combinational logic design; electronic circuits for logic gates; arithmetic circuits; latches and flipflops, registers and counters; synchronous sequential logic and state machine design; implementation in programmable logic chips.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 27

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

ELEC 273 DELETED - Numerical Methods and Optimization W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Number representation in digital computers, error analysis, and iterative calculations. Methods for

finding roots of equations, solving systems of linear algebraic equations, single- and multi-variable optimization, least-squares analysis, curve fitting, differentiation and integration, and solving ordinary differential equations. Implementation of numerical algorithms in software. Nov. 2019

Academic Units:
Mathematics 21
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 0

PREREQUISITE(S): APSC 142 or APSC 143, APSC 174, MTHE 235
EXCLUSION(S): MTHE 272, CIVL 222, CMPE 271

ELEC 274 Computer Architecture W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Number and data representation. Logical structure of computers. Instruction set architecture. Instruction execution sequencing. Assembly-language programming. Input/output interfaces and programming. Processor datapath and control unit design. Semiconductor memory technology and memory hierarchy design.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 22

PREREQUISITE(S): APSC 142 or APSC 143 or MNTC 313, ELEC 271 or MTHE 217 (MATH 217) or permission of instructor
EXCLUSION(S): CISC 221

ELEC 278 Fundamentals of Information Structures F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Fundamentals of Data Structures and Algorithms: arrays, linked lists, stacks, queues, deques, asymptotic notation, hash and scatter tables, recursion, trees and search trees, heaps and priority queues, sorting, and graphs. Advanced programming in the C language. Introduction to object

oriented programming concepts in the context of data structures.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): APSC 142 or APSC 143 or MNTC 313
EXCLUSION(S): CISC 235

ELEC 279 Introduction to Object Oriented Programming W | 4

Lecture: 3
Lab: 1
Tutorial: 0
Introduction to object-oriented design, architecture, and programming. Use of packages, class libraries, and interfaces. Encapsulation and representational abstraction. Inheritance. Polymorphic programming. Exception handling. Iterators. Introduction to a class design notation. Applications in various areas.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 22

PREREQUISITE(S): APSC 142 or APSC 143 or MNTC 313, ELEC 278
EXCLUSION(S): CISC 124, CMPE 212

ELEC 280 Fundamentals of Electromagnetics W | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
A study of the fundamental aspects of electromagnetic fields. The following topics are covered: the Maxwell's equations and the 3-dimensional wave equation for transmission lines; vector analysis, including orthogonal coordinate systems, and the calculus of field quantities; electrostatic fields including the concepts of electric potential, capacitance, and current and current density; magnetostatic fields including inductance; time-varying fields and the complete form of Maxwell's equations; basic transmission line phenomena including steady-state sinusoidal behaviour and standing waves, transient performance and impedance matching.

Academic Units:
Mathematics 0
Natural Sciences 27
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): APSC 112 or APSC 114, APSC 171, APSC 172, APSC 174

ELEC 293 Deleted - Electrical and Computer Engineering Laboratory I |

In this laboratory course, students will explore practical concepts in electric circuits and digital logic circuits. Students will investigate electric circuit operation through circuit simulation, prototyping and testing; and design, implement and test digital logic circuits. The experiments complement material covered in the fall term second year courses on electric circuits and digital systems. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 0

COREQUISITE(S): ELEC 221 and ELEC 271

ELEC 294 Deleted - Electrical and Computer Engineering Laboratory II |

This course is a continuation of ELEC 293. In this course, students will explore concepts in electromagnetics, electric motors and electronic circuits. Students will investigate electromagnetic effects in circuits, the operation of electric motors, the characteristics of electronic devices, and simulate, construct and test electronic circuits. The experiments complement material covered in the winter term second year courses on electromagnetics and electronics. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 4

PREREQUISITE(S): ELEC 293
COREQUISITE(S): ELEC 252

ELEC 299 Mechatronics Project W | K1.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
A team design project based around an autonomous, programmable, robotic vehicle, following on from project activity in APSC 200. Students explore different sensors and software strategies for vehicle control and navigation, in addition to wiring up sensor and motor circuits. The design goal is to configure and program a vehicle to take part in a year-end competition in which robots compete head-to-head on a pre-defined playfield under established competition rules. A final project report must be produced that documents the experimentation, design, and testing. A final exam tests knowledge of sensors and software.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 18

PREREQUISITE(S): ELEC 221, ELEC 271
COREQUISITE(S): ELEC 252, ELEC 280

ELEC 310 DELETED 2018-2019 -Introductory Analog Electronic and Digital Circuits F | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
This is an introductory course on the design of analog electronic and digital logic circuits, using commonly available devices and integrated circuits. The properties of linear circuits, with particular reference to the applications of feedback, are discussed; operational amplifiers are introduced as the fundamental building block for the design of linear filters and amplifiers. Fundamentals of digital circuits including Boolean algebra, logic gates, combinational logic, sequential logic concepts and implementation are presented. Data acquisition and conversion is introduced, and the issues of noise and electromagnetic compatibility are discussed. Laboratory work is linked with lectures and provides practical experience of the subjects covered in lectures. 2018-2019

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 27

PREREQUISITE(S): ELEC 210 or ELEC 221
EXCLUSION(S): ENPH 334 (PHYS 334)

ELEC 323 DELETED - Continuous-Time Signals and Systems F | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
This is a first course on the basic concepts and applications of signals and systems analysis. Continuous time signals and systems are emphasized. Topics include: representations of continuous-time signals; linear time invariant systems; convolution, impulse response, step response; review of Laplace transforms with applications to circuit and system analysis; transfer function; frequency response and Bode plots; filtering concepts; Fourier series and Fourier transforms; signal spectra; AM modulation and demodulation; introduction to angle modulation. Nov. 2019

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 33
Engineering Design 0

PREREQUISITE(S): ELEC 221, MTHE 235 (MATH 235) or MTHE 237 (MATH 237)

ELEC 324 Discrete-Time Signals and Systems F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
This second course on signals and systems studies basic concepts and techniques for analysis and modeling of discrete-time signals and systems. The topics of this course are: sampling, reconstruction, and digitization; representations and properties of discrete-time signals and systems; linear time-invariant (LTI) systems; difference equations; discrete Fourier series; discrete-time Fourier transform; discrete Fourier transform; z-transform; analysis of LTI systems; filtering and spectral analysis. Computational realizations of the analysis tools and their applications are explored in the laboratory.

Academic Units:

Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 0

PREREQUISITE(S): ELEC 323 or ELEC 224

ELEC 326 Probability and Random Processes F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides an introduction to probabilistic models and methods for addressing uncertainty and variability in engineering applications. Topics include sample spaces and events, axioms of probability, conditional probability, independence, discrete and continuous random variables, probability density and cumulative distribution functions, functions of random variables, and random processes.

Academic Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): APSC 171
EXCLUSION(S): MTHE 351 (STAT 351)

ELEC 333 Electric Machines W | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
An introduction to the basic principles, operating characteristics, and design of electric machines. Topics to be studied include: three-phase circuits; magnetic circuits; transformers; steady state behaviours of dc generators and motors; rotating magnetic fields; steady state operation of induction machines and synchronous machines; introduction to fractional horsepower machines; speed control of electric motors.

Academic Units:
Mathematics 0
Natural Sciences 13
Complementary Studies 0

Engineering Science 25
Engineering Design 13

PREREQUISITE(S): ELEC 221

ELEC 344 Sensors and Actuators F | 3.75

Lecture: 3
Lab: 0.75
Tutorial: 0
This course provides an introduction to sensing and actuation in mechatronic systems. The topics include physical principles for the measurement and sensing of displacement, motion, force, torque, pressure, flow, humidity, radiation (visible and IR) and temperature using analog and digital transducers; actuating principles using continuous drive actuators, stepper motors, optical encoders and servo motors; and methods for signal collection, conditioning and analysis.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 18

PREREQUISITE(S): ELEC 221, ELEC 271, ELEC 299, ELEC 252

ELEC 353 Electronics II F | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
Transistor-level modeling and design of analog and digital electronic circuits. Differential amplifiers, Gilbert Cell multipliers, multi-stage amplifiers, amplifier frequency response, negative feedback amplifiers, LC-tank and crystal oscillators, two-port networks. Advanced concepts in logic design. Students learn the basics of computer aided design (CAD) of integrated circuits including schematic simulation, layout, design rules, layout versus schematic verification and extracted circuit simulation. Laboratory work is design-oriented and students are introduced to advanced test and measurement techniques using vector network analyzers.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 25

PREREQUISITE(S): ELEC 252
COREQUISITE(S): ELEC 224 or ELEC 323 or MTHE 334

ELEC 371 Microprocessor Interfacing and Embedded Systems F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Microprocessor bus organization and memory interfaces; parallel input/output interface design; assembly-language and high-level-language programming; interrupts and exceptions; timers; embedded systems organization and design considerations; integration in microcontrollers and programmable logic chips; interfacing with sensors and actuators; embedded system case studies.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 12

PREREQUISITE(S): ELEC 271, CISC 231 or ELEC 274

ELEC 372 Numerical Methods and Optimization W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Number representation in digital computers, error analysis, and iterative calculations. Methods for finding roots of equations, solving systems of linear algebraic equations, single- and multi-variable optimization, least-squares analysis, curve fitting, differentiation and integration, and solving ordinary differential equations. Implementation of numerical algorithms in software.

Academic Units:
Mathematics 21
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 0

PREREQUISITE(S): APSC 142 or APSC 143 or MNTC 313, APSC 174, MTHE 235
EXCLUSION(S): MTHE 272, CIVL 222, ELEC 273

ELEC 373 Computer Networks W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Network architecture with physical, data link, network, and transport layers for frame transmission and packet switching, standards such as Ethernet and 802.11 for wired and wireless networks, protocols such as TCP/IP, internetworking, routing, and socket programming.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 11

PREREQUISITE(S): ELEC 326 or MTHE 351 (STAT 351), ELEC 274 or CISC 221
EXCLUSION(S): CISC 435

ELEC 374 Digital Systems Engineering W | 4.25

Lecture: 3
Lab: 1
Tutorial: 0.25
High-performance logic design for arithmetic circuits; memory system designs based on static and dynamic RAMs; computer bus protocols and standard I/O interfaces; mass storage devices; hardware description languages (VHDL, Verilog); fault testing, design for testability, built-in self-test, memory testing, and boundary-scan architectures; asynchronous sequential circuit design; introduction to GPU architectures and GPU computing. The course is supplemented by a CPU design project that allows students to become proficient with Field Programmable Gate Array (FPGA) devices and associated CAD tools, as well as with GPU computing through nVidia CUDA or OpenCL languages.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 28
Engineering Design 23

PREREQUISITE(S): ELEC 252, ELEC 271, ELEC 274 or permission of the instructor

ELEC 377 Operating Systems F | 4

Lecture: 3
Lab: 1

Tutorial: 0
Operating systems for conventional shared memory computers. System services and system calls, concurrent processes and scheduling, synchronization and communication, deadlock. File systems and protection, memory management and virtual memory, device management and drivers. Unix operating system. Real-time and distributed systems. Security.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 22

PREREQUISITE(S): ELEC 274 or CISC 221 and ELEC 278 or CISC 235
EXCLUSION(S): CMPE 324 (CISC 324)

ELEC 381 Applications of Electromagnetics W | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
Partial differential equation solutions to Maxwell's Equations; Introduction to the Smith chart; uniform plane waves; reflection of plane waves; normal and oblique incidence; analysis and applications of rectangular waveguides; resonant cavities; optical fibres; introduction to antennas; aperture antennas.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 21

PREREQUISITE(S): ELEC 280 or ENPH 231 (PHYS 231) or PHYS 235

ELEC 390 Principles of Design and Development W | K3.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
The goal of this course is to prepare students for definition, design, management, and development of engineering projects and products. Students will learn about problem definition and impact analysis from an economic standpoint as well as other perspectives. Different design principles, management techniques, and development methodologies will be described. Culture

and communication in teams will be discussed, followed by important concepts in ethics and intellectual property. Specific software and tools that are available for facilitating design/development activity will be introduced and utilized throughout the term. Students will apply concepts and explore issues through projects and laboratory activity.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 15
Engineering Science 0
Engineering Design 27

PREREQUISITE(S): Successful completion of Fall term 3rd year studies in either the Electrical Engineering program, or the Computer Engineering program.

ELEC 408 NOT OFFERED 2021-2022 Biomedical Signal and Image Processing W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This is an introductory course in biomedical signal and image processing. Topics include: biopotential generation and detection; the biomedical signals with a focus on the electrocardiogram and electroencephalogram; recording artifacts and signal compression; major medical imaging modalities; 2D and 3D image formation; image processing techniques including spatial and frequency-domain filtering, feature extraction and convolutional neural networks; applications in diagnostics, therapeutics, and interventions.

Academic Units:
Mathematics 0
Natural Sciences 9
Complementary Studies 0
Engineering Science 18
Engineering Design 9

PREREQUISITE(S): ELEC 224 or ELEC 323 or permission of the instructor

ELEC 409 Bioinformatic Analytics F | 3

Lecture: 3
Lab: 0
Tutorial: 0
The course surveys: microarray data analysis methods; pattern discovery, clustering and classification methods; applications to prediction of clinical outcome and treatment response; coding region detection and protein family prediction. At the end of this course, students should

be able to appreciate some approaches related to individualizing medical treatment, as well as to apply some of the methods, such as alternatives to PCA, to more traditional engineering problems.

Academic Units:
Mathematics 9
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 9

PREREQUISITE(S): APSC 174, ELEC 224 or ELEC 323, ELEC 326 or ENPH 252

ELEC 421 Digital Signal Processing: Filters and System Design F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Sampling theorem, filter realization structures, quantization errors and finite word length effects, digital signal processor programming, finite and infinite impulse response filter design techniques, discrete and fast Fourier transform.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24

PREREQUISITE(S): ELEC 324 or MTHE 335

ELEC 422 NOT OFFERED 2021-2022 Digital Signal Processing: Random Models and Applications F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Recent DSP topics including: bandpass sampling, oversampling A/D conversion, quantization noise modelling, multi-rate signal processing, filterbanks, quadrature mirror filters, applications to communications systems, speech and image compression; processing of discrete-time random signals.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 27

PREREQUISITE(S): ELEC 324 or MTHE 335; ELEC 326, or MTHE 351.

ELEC 425 Machine Learning and Deep Learning F | 3.5

Lecture: 3
Lab: 0.25
Tutorial: 0.25
Supervised and unsupervised machine learning methods for regression, classification, clustering, and time series modeling. Methods of fitting models. The problem of overfitting and techniques for addressing it. Deep learning and neural network models. Processes for how to refine/ implement/ test applications of machine/deep learning algorithms.

Academic Units:
Mathematics 11
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 11

PREREQUISITE(S): ELEC 278 or CISC 235, ELEC 326 or permission of the instructor
EXCLUSION(S): CMPE 452

ELEC 431 Power Electronics F | 3.25

Lecture: 3
Lab: 0.25
Tutorial: 0
This course introduces the basic concepts of power electronics, which include power semiconductor devices and switching power converters. Emphasis is placed on the analysis and design of various power electronics circuits. Their industrial application, such as in telecommunications and computing, will also be discussed. More specifically, the course will cover the characteristics of switching devices, especially that of MOSFET. The course will also cover the operation of various switching converters such as phase controlled ACto- DC converters, AC voltage controllers, DC-to-DC switching converters, DC-to-AC inverters and switching power supplies. The requirements and configurations of power systems for telecommunications will be introduced. The techniques to analyze and design these power systems using available components will also be discussed. Computer simulation will be used to analyze the detailed operation of switching converters.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 24

PREREQUISITE(S): ELEC 252

ELEC 433 Energy and Power Systems W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Energy resources and electric power generation with particular emphasis on renewable energy systems such as solar, wind, and biomass; review of balanced and unbalanced 3-phase systems; review of per-unit systems; real and reactive power, sequence networks and unsymmetrical analysis; transmission line parameters; basic system models; steady state performance; network calculations; power flow solutions; symmetrical components; fault studies; short circuit analysis; economic dispatch; introduction to power system stability, operating strategies and control; modern power systems and power converters; DC/AC and AC/DC conversion; and introduction to DC transmission.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 18

PREREQUISITE(S): ELEC 333

ELEC 436 NOT OFFERED 2021-22 Electric Machines and Control W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Review of basic electric machines. Salient pole synchronous machines. Transient and dynamic behaviour of electric machines. Characteristics and applications of special motors such as servo motors, stepper motors, PMmotors, brushless dc motors, switched reluctance motors and linear motors. Solid state speed and torque control of motors.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 18

PREREQUISITE(S): ELEC 333

ELEC 443 Linear Control Systems F | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
Introduction to linear systems and feedback control. Topics include introduction to automatic control, overview of Laplace transformation, linear models of dynamic systems, time-domain specifications of first and second order systems, stability analysis using Routh-Hurwitz criterion, steady-state error and disturbance rejection, PID control, stability analysis and linear controller design using root locus method, Nyquist criterion, and Bode plots, and introduction to state-space analysis. These methods are applied and tested using software such as MATLAB/Simulink, and laboratory experiments.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 36

PREREQUISITE(S): ELEC 323 or ELEC 224 or MTHE 335 (MATH 335)

ELEC 444 NOT OFFERED 2021-2022 Modeling and Computer Control of Mechatronic Systems W | 3.25

Lecture: 3
Lab: 0.25
Tutorial: 0
This course provides an introduction to modeling and analysis of the dynamics of mechatronic processes and computer control of such systems. Topics include modeling and simulation of mechanical, electrical, thermal, and fluid systems, sampled-data systems and equivalent discrete system, overview of Z-transform, dynamic response of second-order discrete systems, stability analysis and design of linear discrete-time control systems using root locus and frequency response methods. The modeling and controller design methods are implemented and tested using MATLAB/Simulink and laboratory experiments.

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 29
Engineering Design 10

PREREQUISITE(S): ELEC 324, ELEC 344, ELEC 443

ELEC 448 Introduction to Robotics: Mechanics and Control F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Robotics is an interdisciplinary subject concerning areas of mechanics, electronics, information theory, control systems and automation. This course provides an introduction to robotics and covers fundamental aspects of modeling and control of robot manipulators. Topics include history and application of robotics in industry, rigid body kinematics, manipulator forward, inverse and differential kinematics, workspace, singularity, redundancy, manipulator dynamics, trajectory generation, actuators, sensors, and manipulator position and contact force control strategies. Applications studied using MATLAB/Simulink software simulation and laboratory experiments.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 16
Engineering Design 26

COREQUISITE(S): ELEC 443 or MTHE 332 or MECH 350
EXCLUSION(S): MECH 456

ELEC 451 Digital Integrated Circuit Engineering F | 3.25

Lecture: 3
Lab: 0.25
Tutorial: 0
Review of MOS transistor structure and operation; overview of wafer processing and device implementation, layout and design rules. CMOS gate design; static and dynamic logic; modelling of transients and delays. Clocked circuits; interconnect effects, and I/O. Memory and programmable logic arrays. Technology scaling effects; design styles and flow.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Science 21
Engineering Design 18

PREREQUISITE(S): ELEC 252 , ELEC 271

ELEC 454 NOT OFFERED 2021-2022 Analog Electronics W | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
Topics include; an introduction to noise and distortion in electronic circuits, analysis and design of biasing circuits, references, ADCs and DACs, power amps, mixers, modulators and PLLs along with a short introduction to analog filter design.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 19

PREREQUISITE(S): ELEC 323 or MTHE 332 (MATH 332), ELEC 353

ELEC 457 Integrated Circuits and System Applications W | 3.25

Lecture: 3
Lab: 0.25
Tutorial: 0
In the first part of this course modern microelectronic circuits are covered and in the second part these circuits are used in new and emerging applications. Topics include: active and passive filtering circuits, phase locked loops, frequency synthesizers, RF modulators, clock and data recovery circuits, RF energy harvesting, ultra low-power circuits, biotelemetry systems, biological sensors, neurostimulator circuits, introduction to radiometry and radar imaging.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 21

PREREQUISITE(S): ELEC 353, ELEC 224 or ELEC 323 or MTHE 335

ELEC 461 NOT OFFERED 2021-2022 Digital Communications F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Representation of signals and noise, Gaussian processes, correlation functions and power spectra. Linear systems and random processes. Performance analysis and design of coherent and noncoherent communication systems, phase-shift-keying, frequency-shift,-keying, and M-ary communication systems. Optimum receivers and signal space concepts. Information and its measure, source encoding, channel capacity and error correcting coding.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21

PREREQUISITE(S): ELEC 324 or MTHE 335, ELEC 326 or MTHE 351, or permission of instructor

ELEC 464 Wireless Communications F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Fundamental principles and practice of current wireless communications systems and technologies. Historical context, the wireless channel including path loss, shadowing, fading, and system modes in use. Capacity limitations on transmission rate, transmission of data by signaling over wireless channels via digital modulation, optimum receivers, countermeasures to fading and interference via diversity and equalization, multiple user systems including multiple access FDMA, TDMA, CDMA, FDMA/TDMA, uplink and downlink; capacity and power control, design of cellular networks. Selected standards and emerging trends are also surveyed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 18

PREREQUISITE(S): ELEC 324, ELEC 326

ELEC 470 Computer System Architecture W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course covers advanced topics in computer architecture with a quantitative perspective. Topics include: instruction set design; memory hierarchy design; instruction-level parallelism (ILP), pipelining, superscalar processors, hardware multithreading; thread-level parallelism (TLP), multiprocessors, cache coherency; clusters; introduction to shared-memory and message-passing parallel programming; data-level parallelism (DLP), GPU architectures.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 31

PREREQUISITE(S): ELEC 371, ELEC 274 or CISC 221

ELEC 472 Artificial Intelligence W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Fundamental concepts and applications of intelligent and interactive system design and implementation. Topics include: problem formulation and experiment design, search techniques and complexity, decision making and reasoning, data acquisition, data pre-processing (de-noising, missing data, source separation, feature extraction, feature selection, dimensionality reduction), supervised learning, unsupervised learning, and swarm intelligence.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 11

PREREQUISITE(S): ELEC 278, ELEC 326 or permission of the instructor

ELEC 473 Cryptography and Network Security F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Cryptography topics include: block ciphers, advanced encryption standard, public key encryption,

hash functions, message authentication codes, digital signatures, key management and distribution, and public-key infrastructure. Network security topics include: user authentication, network access control, Kerberos protocol, transport layer security (TLS), IP security (IPSec), electronic mail security, and wireless network security.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 10

PREREQUISITE(S): ELEC 373 or CISC 435, ELEC 270 or CISC 102 or permission of instructor

ELEC 474 Machine Vision F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Image acquisition and representation, spatial domain filtering, edge detection, motion segmentation, interest operators and feature extraction, camera models, epipolar geometry and stereovision, machine learning approaches and convolutional neural networks, classification, object detection, semantic segmentation, and GANs. The lab and assignments will emphasize practical examples of machine vision techniques to industrial and mechatronic applications.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 11

PREREQUISITE(S): ELEC 278 or CISC 235
EXCLUSION(S): CMPE 457

ELEC 476 DELETED - Modelling and Systems Simulation W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Overview of techniques for the performance evaluation of computer systems and networks. Discrete event digital simulation of stochastic processes. Simulation methodology. Design of simulation experiments. Analysis and validation of simulation models and results. Operational

analysis. Deleted 2016-2017

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 30

PREREQUISITE(S): ELEC 326 or MTHE 351 (STAT 351)

ELEC 478 DELETED - Computer Networks II W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to communication networks design principles, data encoding, media access sublayer, local area networks, protocol analysis, mobile communication networks and network security. No

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 10
Engineering Design 26

PREREQUISITE(S): ELEC 326 or MTHE 351 (STAT 351), ELEC 373 or CISC 435

ELEC 481 NOT OFFERED 2021-2022 Applications of Photonics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Overview of light-matter interaction, design of optical waveguides, modeling of photonic devices, light propagation in periodic and subwavelength structures. Applications of photonics in LIDAR for autonomous vehicles, design of optical phased array, design of holography, medical imaging and sensing, optoelectronics and renewable energy.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 18

PREREQUISITE(S): ELEC 381

ELEC 483 Microwave and RF Circuits and Systems W | 4.25

Lecture: 3
Lab: 0.75
Tutorial: 0.5
This course introduces the analysis and design of microwave components and systems. Topics include: modeling of high frequency circuits; transmission lines; scattering parameters; impedance matching; passive microwave components; amplifiers, mixers and oscillators; noise in receivers; elemental antennas and simple and phased arrays; communication links - microwave land, cellular and satellite systems; performance and link budget analysis. The laboratory work is design oriented and implements the lecture material.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 25

PREREQUISITE(S): ELEC 353, ELEC 381 or ENPH 332 (PHYS 332)

ELEC 486 Fiber Optic Communications F | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
This course introduces fundamental principles and applications of fiber optic communication systems. Topics include Fabry-Perot and distributed feedback semiconductor lasers, planar dielectric waveguides, propagation characteristics of single-mode optical fibers, p-i-n and avalanche photodiodes, and digital receiver performance. Device technology and system design applications are considered.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 24

PREREQUISITE(S): ELEC 381 or ENPH 431

ELEC 490 Electrical Engineering Project FW | K7

Lecture: Yes
Lab: Yes
Tutorial: Yes
Students work in groups of three on the design and implementation of electrical engineering projects, with the advice of faculty members. This course is intended to give students an opportunity to practice independent design and analysis. Each group is required to prepare an initial engineering proposal, regular progress reports, and a final report together with a formal seminar on the project and its results.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 21
Engineering Science 0
Engineering Design 63

PREREQUISITE(S): ELEC 324, ELEC 326, ELEC 353, ELEC 371, ELEC 372, ELEC 381, ELEC 390, or permission of the department

ELEC 491 Advanced ECE Thesis I S | 6

Lecture: 0
Lab: 6
Tutorial: 0
Students will be assigned individual Research Topics. Students must work under the supervision of a faculty member. Grade will be based on the progress in arriving at a solution to the assigned problem.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 54
Engineering Design 18

PREREQUISITE(S): Permission of Thesis Supervisor

ELEC 492 Advanced ECE Thesis II FW | 6

Lecture: 0
Lab: 6
Tutorial: 0

The students continue working on their assigned problems in ELEC 491 under the supervision of the same faculty member. Upon completion of their thesis, students must give oral and written presentations. Grades will be based on the quality of the analysis of the problem, the proposed solution, and written and oral presentations. Demonstration of effective written and oral communications skills is required.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 54
Engineering Design 18

PREREQUISITE(S): ELEC 491

ELEC 497 Research Project FW/S | K3.5

Lecture: no
Lab: no
Tutorial: no
The student works on a research project under the supervision of a faculty member. A research problem is formulated and the problem is contextualized within the discipline. The student does a current literature review, and explores in detail a solution to the research problem. Subject to Department approval.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21

EXCLUSION(S): ELEC 491

ELEC 498 Computer Engineering Project FW | K7

Lecture: Yes
Lab: Yes
Tutorial: Yes
Students work in groups of three on the design and implementation of computer engineering projects, with the advice of faculty members. This course is intended to give students an opportunity to practice independent design and analysis. Each group is required to prepare an initial engineering proposal, regular progress reports, and a final report together with a formal seminar on the project and its results.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 21
Engineering Science 0
Engineering Design 63

PREREQUISITE(S): ELEC 326, ELEC 371, ELEC 374, ELEC 377, ELEC 390, CMPE 223 (CISC 223) or CMPE 320 (CISC 320), or permission of the department

SOFT 423 Software Requirements W | 3

Lecture: 3
Lab: 0
Tutorial: 0
An integrated approach to discovering and documenting software requirements. Identification of stakeholders; customer, operator, analyst, and developer perspectives. Requirements elicitation. Transition from initial (informal) requirements to semi-formal and formal representations. Requirements analysis process; analysis patterns. Requirements specification techniques. Relation to architecture and user interface design; traceability of requirements. Alternately offered as CISC 423.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): CMPE 223
COREQUISITE(S): CMPE 322
EXCLUSION(S): CISC 423

SOFT 437 Performance Analysis W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Analytic and empirical evaluation of the performance of software systems. Performance modeling. Experimental design and statistical techniques for empirical performance analysis. Alternately offered as CISC 437.

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): CMPE 324 (CISC 324) or ELEC 377, or permission of the instructor

Engineering Chemistry

ENCH 211 Main Group Chemistry F | 4.75

Lecture: 3
Lab: 1.5
Tutorial: 0.25
An introduction to chemistry of main group inorganic and organic compounds with the use of fundamental quantum mechanics, molecular orbital diagrams and Lewis structures to describe the structure and bonding. The stereochemistry and chirality of organic compounds, solid-state inorganic chemistry, and descriptive chemistry of compounds of the main group elements will be covered. The laboratory will introduce skills in inorganic and organic synthesis.

Academic Units:
Mathematics 0
Natural Sciences 58
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132

ENCH 212 Principles of Chemical Reactivity F | 4

Lecture: 3
Lab: 0.75
Tutorial: 0.25
An introduction to the kinetics and mechanisms of reactions in gaseous and condensed phases, including acid-base and nucleophilic substitution reactions at carbon and other main group centers. Other topics will include molecular dynamics and reactions in solution. The laboratory illustrates measurement techniques and develops laboratory skills

Academic Units:
Mathematics 0
Natural Sciences 49
Complementary Studies 0

Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 112, APSC 131, APSC 132

ENCH 213 Introduction to Chemical Analysis F | 4.75

Lecture: 3
Lab: 1.5
Tutorial: 0.25
Introduction to analytical chemical methods and science. Topics include statistical analysis of data, titrations and equilibrium theory, spectrophotometry and instrumental elemental analysis.

Academic Units:
Mathematics 0
Natural Sciences 43
Complementary Studies 0
Engineering Science 15
Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132

ENCH 222 Methods of Structure Determination W | 3.75

Lecture: 3
Lab: 0
Tutorial: 0.75
A survey of practical spectroscopic and spectrometric methods for the determination of the structures of organic and inorganic compounds. Methods will include nuclear magnetic resonance, electronic, infrared/ Raman spectroscopy, and mass spectrometry. Tutorials will involve solving compound structures using spectroscopic data, and include an introduction to computational methods in spectroscopy.

Academic Units:
Mathematics 0
Natural Sciences 45
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): (APSC 131 and APSC 132) or CHEM 112.

ENCH 245 Applied Organic Chemistry I W | 4.75

Lecture: 3
Lab: 1.5
Tutorial: 0.25
A survey of organic functional group reactivity from a mechanistic perspective, including substitution, addition, elimination, rearrangement and redox reactions; extensive use of examples from industrial process chemistry. The laboratory provides experience in organic synthesis, including the preparation, purification and characterization of organic compounds.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 16
Engineering Design 0

PREREQUISITE(S): ENCH 211 (CHEM 211), ENCH 212 (CHEM 212)
EXCLUSION(S): CHEM 223

ENCH 311 Mechanistic Organic Chemistry F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Fundamental mechanistic concepts of organic reactions, structure activity relationships, solvent effects and catalysis. Mechanistic aspects of substitution, addition, elimination and pericyclic reactions.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 245

ENCH 312 Transition Metal Chemistry F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction to the chemistry, bonding and structures of coordination compounds of the transition metals; transition metals in the solid state and in biological systems; industrial and environmental aspects of transition metal chemistry.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 211 (CHEM 211)

ENCH 313 Quantum Mechanics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Elementary principles and applications of wave mechanics with special reference to molecular orbitals and chemical bonding.

Academic Units:
Mathematics 0
Natural Sciences 21
Complementary Studies 0
Engineering Science 21
Engineering Design 0

PREREQUISITE(S): CHEE 210, MTHE 225 (MATH 225)

ENCH 321 Instrumental Chemical Analysis W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Overview of instrumental methods of chemical analysis. Topics include gas and liquid chromatography, mass spectrometric detection, new separations methods, electrochemical analysis, inductively coupled plasma-based elemental analysis.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 213 (CHEM 213)

ENCH 322 The Chemical Bond: Computation and Spectroscopy W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The application of quantum mechanics to the structures and internal motions of molecules. The foundations of electronic, vibrational, rotational and NMR spectroscopy will be discussed together with their applications.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 313

ENCH 323 Biological Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Introduction to the chemical basis of biological systems and biomolecules; protein structure and synthesis, enzyme catalysis, nucleic acids (DNA, RNA), carbohydrates, membranes, cell signalling, biosynthetic and metabolic pathways.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): CHEE 342 or CHEE 324

ENCH 326 Environmental and Green Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
The first part examines chemical contaminants in the atmosphere, water, soils and sediments, including sources, behaviour, transport, and distribution among these environments. The second part introduces Green chemistry, examining industrial sources of contaminants and the

modification of industrial processes in order to minimize environmental impact.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 12
Engineering Design 0

PREREQUISITE(S): ENCH 211 (CHEM 211), ENCH 212 (CHEM 212), ENCH 245

ENCH 345 Deleted-Applied Organic Chemistry II W | 3

Lecture: 3
Lab: 0
Tutorial: 0
A detailed study of organic reactions and processes of industrial and economic importance, with application of the principles developed in ENCH 245 (CHEM 245). Case studies involving process development in the pharmaceutical industry are used extensively. Nov. 2018

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 12
Engineering Design 0

PREREQUISITE(S): ENCH 245 or permission of the instructor

ENCH 397 Experimental Chemistry FW | 7

Lecture: 3
Lab: 0.5
Tutorial: 0
Laboratory course introducing modern experimental methods in chemistry, including synthesis, analytical instrumentation and computational methods. The integration of several methods will be emphasized in the synthesis and characterization of molecules.

Academic Units:
Mathematics 0
Natural Sciences 84
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): At least 6 units at the 200-level in ENCH/CHEM or permission of the Department.
COREQUISITE(S): At least 3 units at the 300-level in ENCH/CHEM or permission of the Department.

ENCH 398 Experimental Chemistry I F | 3.5

Lecture: 0
Lab: 3
Tutorial: 0.5
Laboratory course. In consultation with the course coordinator, and subject to availability, students may select experiments as are relevant to their degree program including synthesis, analytical instrumentation and computational methods. The integration of several methods will be emphasized in the design and characterization of molecules.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): (ENCH 211 or ENCH 212), ENCH 222, ENCH 245
COREQUISITE(S): At least 3 units at the 300-level in ENCH/CHEM or permission of the Department.

ENCH 399 Experimental Chemistry II W | 3.5

Lecture: 0
Lab: 3
Tutorial: 0.5
Laboratory course. In consultation with the course coordinator, and subject to availability, students may select experiments as are relevant to their degree program including synthesis, analytical instrumentation and computational methods. The integration of several methods will be emphasized in the design and characterization of molecules.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): (ENCH 211 or ENCH 212), ENCH 222, ENCH 245.
COREQUISITE(S): At least 3 units at the 300-level in ENCH/CHEM

ENCH 411 Advanced Analytical Chemistry F | 3

Lecture: 3
Lab: 0
Tutorial: 0
A discussion of recent advances in analytical chemistry and its applications to the environmental, materials and biomedical fields. At least four topics will be covered from sample preparation, separation methods, multidimensional chromatography, elemental spectroscopy, mass spectroscopy, and surface analysis methods. Additional topics will be selected from the current literature.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 213

ENCH 412 NOT OFFERED 2021-2022 - Statistical Mechanics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
The fundamentals of statistical mechanics with applications to thermodynamic properties of gases, liquids and solids and to chemical equilibrium in dilute gases.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 313

ENCH 413 Computational Chemistry F | 3

Lecture: 3
Lab: 0

Tutorial: 0
The application of quantum mechanics to chemical structures, energetics, internal motions of molecules, and chemical reactions. An introduction to the use of modern electronic structure software in chemistry.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 313 (CHEM 313)

ENCH 414 Catalysis F | 3

Lecture: 3
Lab: 0
Tutorial: 0
An advanced treatment of the concepts and applications of catalysis, including the kinetics of catalysis and topics selected from the areas of homogeneous, heterogeneous, and biocatalysis.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 245 and ENCH 312 (CHEM 312)

ENCH 415 Electrochemistry and Electrocatalysis W | 3

Lecture: 3
Lab: 0
Tutorial: 0
The course covers concepts of equilibrium electrochemistry and examines the structure of the electrode-solution interface. It discusses the basics of electron transfer and derives electrochemical kinetics equations. It shows examples of several electrochemical reactions and overviews experimental methods used to study electrochemical phenomena.

Academic Units:
Mathematics 0
Natural Sciences 36

Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): CHEE 210

ENCH 417 Research Project FW | 9

Lecture: 0
Lab: 9
Tutorial: 0
In this course, projects will be assigned requiring design and synthesis in the solution of problems in engineering chemistry, using principles and concepts discussed in previous courses. Originality and innovation are encouraged. Students are required to significantly contribute to the design of original experiments, and independently analyze, interpret and communicate the results, both orally and in writing.

Academic Units:
Mathematics 0
Natural Sciences 53
Complementary Studies 27
Engineering Science 28
Engineering Design 0

PREREQUISITE(S): ENCH 397 or ENCH 398 or ENCH 399

ENCH 421 Advanced Methods in Physical Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Modern spectroscopic methods for the structural and electronic characterization of molecules will be discussed, including: NMR, X-ray and synchrontron-based spectroscopies, laser spectroscopy, surface spectroscopic methods, and scanning probe methods.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 313 (CHEM 313)

ENCH 422 Synthetic Organic Chemistry W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Modern synthetic methods in organic chemistry. Principles of strategy in planning organic syntheses based on simple classifications of reagents and reactions, and on the control of stereochemistry.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): CHEE 324

ENCH 423 Topics in Inorganic and Organometallic Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
An examination of aspects of modern inorganic and organometallic chemistry. Topics will include metal-ligand bonding in organometallic complexes, applications of organometallics in organic synthesis, metal-metal bonding in dinuclear and polynuclear metal complexes, and may include reaction mechanisms of transition metal complexes, bioinorganic chemistry and symmetry.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 312 (CHEM 312)

ENCH 424 NOT OFFERED 2021-2022 Polymer Chemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Specific properties of polymers (glass transition, crystallinity, polydispersity, etc) and their

dependence on macromolecular structure and isomerism. Polymer synthesis overview: step and chain polymerization (free-radical, ionic and insertion mechanisms) and reactions on polymers. Examples of polymers and their uses.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): CHEM 223 or ENCH 245

ENCH 425 Self-Assembly and Materials W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Four topics covering a range of self-assembled molecular systems will be discussed: monolayers and bilayers, block co-polymers, nanoparticles, and liquid crystals. Material properties, synthetic methods and application of these systems in current and emerging technologies, including nanotechnologies, will be covered.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): CHEE 210 and ENCH 245 or CHEM 221 and CHEM 223

Engineering Physics

ENPH 211 Applied Physics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course stresses the creation of physical models for real systems. Applications of vibrational motion are developed and a basic description of the properties of elastic media given. The methods required to predict the performance of physical or engineering systems are demonstrated using examples drawn from various fields of science and engineering with emphasis on mechanics and vibrations, waves and optics.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 31
Engineering Design 0

COREQUISITE(S): ENPH 225

ENPH 213 Computational Engineering Physics W | 4

Lecture: 2
Lab: 1.5
Tutorial: 0.5
Introduction to the use of numerical methods in solving physics and engineering problems. A high-level language appropriate for engineering, such as MATLAB, will be introduced and used throughout the course. Possible topics to be covered include numerical differentiation and integration, root finding and optimization problems, solution of linear systems of equations, finite-element modelling, fast Fourier transforms and Monte Carlo simulations.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 15

PREREQUISITE(S): APSC 142, MTHE 227 (MATH 227), MTHE 237 (MATH 237) or MTHE 225, ENPH 242 (PHYS 242)
COREQUISITE(S): ENPH 211 (PHYS 211), ENPH 225 (PHYS 225), ENPH 239
EXCLUSION(S): CMPE 271

ENPH 225 Mechanics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Extension of classical mechanics and engineering applications. Plane dynamics, relative motion and forces in moving and accelerated reference frames. Introduction to general three-dimensional motion of a rigid body, inertia tensor and steady-state precession. The laws of conservation of mass, momentum and energy.

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 112, APSC 171, APSC 172, APSC 174

ENPH 239 Electricity and Magnetism W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The experimental basis and mathematical description of electrostatics, magnetostatics and electromagnetic induction, together with a discussion of the properties of dielectrics and ferromagnetics, are presented. Both the integral and vector forms of Maxwell's equations are deduced.

Academic Units:
Mathematics 0
Natural Sciences 17
Complementary Studies 0
Engineering Science 25
Engineering Design 0

PREREQUISITE(S): MTHE 227 (MATH 227) or MTHE 280 (MATH 280); APSC 111 and APSC 112

ENPH 242 Relativity and Quanta F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Evidence for relativistic effects. Kinematics and dynamics in special relativity, Minkowski diagram, applications. Evidence for quanta, spectra, Bohr atom, quantum statistics. Descriptive nuclear physics, radioactivity, elementary particles.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 112
EXCLUSION(S): PHYS 342

ENPH 251 Deleted - Engineering Physics Laboratory and Statistics FW | 4.25

Lecture: 1
Lab: 3
Tutorial: 0.25
The demonstration of the basic techniques of the engineering physicist in the measurement of electric, magnetic, thermal and mechanical properties. The emphasis is on correct measurement techniques, treatment of results and the presentation of data. Error and uncertainties in experimental measurement, the propagation of errors. Probability and the Binomial, Poisson and Gaussian distribution functions, fitting of Poisson and Gaussian distributions to a sample population. Linear least squares fit, chi-squared. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 8
Natural Sciences 8
Complementary Studies 6
Engineering Science 28
Engineering Design 0

COREQUISITE(S): ENPH 225, ENPH 239 and ENPH 274
EXCLUSION(S): ENPH 252 (PHYS 252)

ENPH 252 Management of Experimental Data W | 1.25

Lecture: 1
Lab: 0
Tutorial: 0.25
Error and uncertainties in experimental measurement, the propagation of errors. Probability and the Binomial, Poisson and Gaussian distribution functions, fitting of Poisson and Gaussian distributions to a sample population. Linear least-squares fitting, chi-squared. The graphical treatment and presentation of data; regression and power law analyses.

Academic Units:
Mathematics 8
Natural Sciences 0
Complementary Studies 0
Engineering Science 6
Engineering Design 0

ENPH 253 Engineering Physics Laboratory W | K3.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
The demonstration of the basic techniques of the engineering physicist in the measurement of electric, magnetic and mechanical properties. The emphasis is on correct measurement techniques, error analysis, treatment of results and the presentation of data.

Academic Units:
Mathematics 0
Natural Sciences 15
Complementary Studies 12
Engineering Science 15
PREREQUISITE(S): ENPH 252 (PHYS 252)
COREQUISITE(S): ENPH 211, ENPH 225, ENPH 239

ENPH 274 Deleted - Thermodynamics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Thermodynamics applied to engineering systems. Ideal gas properties and real thermodynamic working substances. First law using control mass and control volume. Second law, entropy, Carnot cycle, power and refrigeration cycles. Reversible flow processes. Introduction to fluid mechanics and flow measurement. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 6
Complementary Studies 0
Engineering Science 28
Engineering Design 8

PREREQUISITE(S): APSC 111, APSC 112, APSC 171, APSC 172, APSC 174

ENPH 312 DELETED - Mathematical Methods in Physics FW | 7

Lecture: 6
Lab: 0
Tutorial: 1
Methods of mathematics important for physicists. Functions of a complex variable, contour integration, partial differential equations, orthogonal functions, Green functions, Fourier series, Fourier and Laplace transforms, finite difference methods, numerical solution of ordinary and partial differential equations. Deleted 2016-2017

Academic Units:
Mathematics 63
Natural Sciences 21
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): MTHE 227 (MATH 227), MTHE 237 (MATH 237), ENPH 211 (PHYS 211)

ENPH 316 Mathematical Methods in Physics I F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Methods of mathematics important for physicists. Complex arithmetic, series expansions and approximations of functions, Fourier series and transforms, vector spaces and eigenvalue problems, and differential equations.

Academic Units:
Mathematics 31
Natural Sciences 11
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): MTHE 227 (MATH 221 or MATH 280), MTHE 237 (MATH 225 or MATH 231) or MTHE 225
EXCLUSION(S): ENPH 312 (PHYS 312), MTHE 338 (MATH 338), MTHE 334 (MATH 334), MTHE 335 (MATH 335)

ENPH 317 Mathematical Methods in Physics II W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A continuation of PHYS 316. Partial differential equations, functions of a complex variable and contour integration, and special topics such as probability and statistics, group theory and non-linear dynamics

Academic Units:
Mathematics 31
Natural Sciences 11
Complementary Studies 0

Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENPH 316 (PHYS 316)
EXCLUSION(S): ENPH 312 (PHYS 312), MTHE 338 (MATH 338), MTHE 334 (MATH 334), MTHE 335 (MATH 335)

ENPH 321 Advanced Mechanics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the equations of mechanics using the Lagrange formalism and to the calculus of variations leading to Hamilton's principle. The concepts developed in this course are applied to problems ranging from purely theoretical constructs to practical applications. Links to quantum mechanics and extensions to continuous systems are developed.

Academic Units:
Mathematics 11
Natural Sciences 20
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): ENPH 211 (PHYS 211), MTHE 226 (MATH 226) or MTHE 237 (MATH 237) or MTHE 225, MTHE 227 (MATH 227)

ENPH 332 Deleted - Electromagnetic Theory W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to electromagnetic theory and some of its applications. Topics are: Maxwell's equations, properties of waves in free space, dielectrics, conductors and ionized media, reflection and refraction at the surfaces of various media, radiation of electromagnetic waves, antennae, wave-guides, and optical fibers. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 21
Complementary Studies 0
Engineering Science 21
Engineering Design 0

PREREQUISITE(S): ENPH 239 (PHYS 239) or PHYS 235 or ELEC 280, MTHE 226 (MATH 226) or MTHE 235 (MATH 235) or MTHE

ENPH 333 Deleted - Electronics for Scientists and Engineers |

The design of electronic circuits and systems, using commonly available devices and integrated circuits. The properties of linear circuits are discussed with particular reference to the applications of feedback; operational amplifiers are introduced as fundamental building blocks. Digital circuits are examined and the properties of the commonly available I.C. types are studied; their use in measurement, control and signal analysis is outlined. Laboratory work is closely linked with lectures and provides practical experience of the subjects covered in lectures. - COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 27

PREREQUISITE(S): ELEC 210 or ELEC 221
EXCLUSION(S): ENPH 334 (PHYS 334)

ENPH 334 Electronics for Applied Scientists F | 5

Lecture: 3
Lab: 1.5
Tutorial: 0.5
The design of electronic circuits and systems, using commonly available devices and integrated circuits. The properties of linear circuits are discussed with particular reference to the applications of feedback; operational amplifiers are introduced as fundamental building blocks. Digital circuits are examined and the properties of the commonly available I.C. types are studied; their use in measurement, control and signal analysis is outlined. Laboratory work is closely linked with lectures and provides practical experience of the subjects covered in lectures.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 27

PREREQUISITE(S): ELEC 221
EXCLUSION(S): ENPH 333 (PHYS 333)

ENPH 336 Solid State Devices W | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
This course deals with the fundamental concepts of solid state materials and the principles of operation of modern electronic and optoelectronic devices. Topics in materials include crystal structure, energy bands, carrier processes and junctions. Topics in device operation include p-n junction diodes, bipolar junction transistors, field-effect junction transistors, metal-oxide-semiconductor field-effect transistors, and optoelectronic devices.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Science 21
Engineering Design 0

PREREQUISITE(S): ELEC 252, ELEC 280 or ENPH 239 (PHYS 239)
EXCLUSION(S): PHYS 335

ENPH 344 Introduction to Quantum Mechanics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Matter waves. Postulates of wave mechanics. Stationary states and one-dimensional potentials. Particle tunnelling and scattering states. Introduction to matrix mechanics and Dirac notation. Quantized angular momentum, and the H atom.

Academic Units:
Mathematics 11
Natural Sciences 31
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): MTHE 237 (MATH 225 or MATH 231 or MATH 232) or MTHE 225, MTHE 227 (MATH 221 OR MATH 280), ENPH 242 (PHYS 242), ENPH 211 (PHYS 211)
EXCLUSION(S): CHEM 313

ENPH 345 Quantum Physics of Atoms, Nuclei and Particles W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Spin. Addition of angular momentum. Many electron atoms and the periodic table. Introduction to perturbation theory and Fermi's golden rule. Time dependent perturbations, including stimulated emission. Introduction to nuclear and particle physics.

Academic Units:
Mathematics 11
Natural Sciences 20
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): ENPH 344 (PHYS 344)

ENPH 351 Deleted - Engineering Physics Laboratory F | 2

Lecture: 0
Lab: 2
Tutorial: 0
Selected experiments in electron physics, quantum physics, nuclear physics, optics, and heat illustrating the development of modern physics concepts. The laboratory work introduces advanced measurement techniques and includes an experimental project in modern physics with oral presentations. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 4
Complementary Studies 6
Engineering Science 4
Engineering Design 10

COREQUISITE(S): PHYS 342 or ENPH 344 (PHYS 344)

ENPH 352 Deleted - Measurement, Instrumentation and Experiment Design W | 4

Lecture: 3
Lab: 1
Tutorial: 0
Methods of measurement of a wide range of quantities are discussed with particular reference to instrumentation and equipment used in current physics and engineering practice. The emphasis is on experiment and system design including the use of analog and digital signal processing methods for signal to noise enhancement. A major section of the course covers the use of nuclear

and x-ray methods in applied physics. Current legislation related to health and safety is reviewed. An associated laboratory provides experience in modern instrumentation. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 2
Engineering Science 22
Engineering Design 24

PREREQUISITE(S): ENPH 239 (PHYS 239) or PHYS 235, PHYS 342 or ENPH 344 (PHYS 344)
COREQUISITE(S): PHYS 343 or ENPH 345

ENPH 353 Engineering Physics Laboratory II F | 2.5

Lecture: 1
Lab: 1.5
Tutorial: 0
Selected experiments in electron physics, quantum physics, nuclear physics and optics illustrating the development of modern physics concepts. The lectures cover methods of measurement of a wide range of quantities, with emphasis on instrumentation and equipment used in current physics and engineering practice. The laboratory work introduces advanced measurement techniques and important concepts in modern physics.

Academic Units:
Mathematics 0
Natural Sciences 8
Complementary Studies 8
Engineering Science 14
Engineering Design 0

PREREQUISITE(S): ENPH 251 (PHYS 251) OR ENPH 253
COREQUISITE(S): ENPH 344
EXCLUSION(S): ENPH 351 (PHYS 351)

ENPH 354 Engineering Physics Design Project W | 3.5

Lecture: 1
Lab: 2.5
Tutorial: 0
Students will apply technical knowledge, models, and computer-aided design tools to solve an open-ended design problem. The students will work in teams to design, built, and test a prototype

device. The lectures provide background on the physics and engineering of the device and introduce the design tools and techniques that will be required to complete the project.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 31

PREREQUISITE(S): APSC 200, APSC 293, ENPH 253 or ENPH 251 (PHYS 251), ENPH 213 or CMPE 271, ENPH 334 or ELEC 252
COREQUISITE(S): APSC 221ENPH 213 Computational Engineering Physics W | 4CMPE 271 DELETED - Scientific Computing W | 3ENPH 334 Electronics for Applied Scientists F | 5ELEC 252 Electronics I W | 4.25

ENPH 372 Thermodynamics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Temperature, equations of state, internal energy, first and second laws, entropy and response functions. Application to heat engines and refrigerators. Free energies, Legendre transformations, changes of phase. Introduction to the Boltzmann factor and statistical mechanics. First offering in winter 2013.

Academic Units:
Mathematics 0
Natural Sciences 31
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): ENPH 242 (PHYS 242)
EXCLUSION(S): ENPH 274 (PHYS 274)

ENPH 380 Deleted - Electrical and Optical Properties of Solids W | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
An introduction to the electrical and optical properties of insulators, semiconductors and metals. Introduction to Fermi-Dirac statistics, crystal structures, band theory, and electron transport. The physics behind diodes, field effect and bipolar transistors, and other discrete devices. - COURSE

DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 10
Complementary Studies 0
Engineering Science 27
Engineering Design 2

PREREQUISITE(S): ENPH 239 (PHYS 239), ENPH 344 (PHYS 344)

ENPH 414 Introduction to General Relativity W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Einstein's theory of gravity is developed from fundamental principles to a level which enables the student to read some of the current literature. Includes an introduction to computer algebra, an essential element of a modern introduction to Einstein's theory.

Academic Units:
Mathematics 12
Natural Sciences 24
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENPH 321 (PHYS 321), ENPH 316 (PHYS 316) and ENPH 317 (PHYS 317) or ENPH 312 (PHYS 312) or MTHE 338 (MATH 338)

ENPH 422 Deleted - Fluid Mechanics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A survey of the physics of fluids. The fundamental principles and the range of validity of the usual approximation methods are stressed. Topics include a study of incompressible flow, both laminar and turbulent, boundary layers, stratified flow and waves, with a brief introduction to gas dynamics, magnetohydrodynamics and plasma physics. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0

Engineering Science 24
Engineering Design 0

PREREQUISITE(S): ENPH 225 (PHYS 225), MATH 436 or MTHE 338 (MATH 338)

ENPH 431 Electromagnetic Theory F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to electromagnetic theory and some of its applications. Topics are: Maxwell's equations, properties of waves in free space, dielectrics, conductors and ionized media, reflection and refraction at the surfaces of various media, radiation of electromagnetic waves, antennae, wave-guides, and optical fibers.

Academic Units:
Mathematics 0
Natural Sciences 21
Complementary Studies 0
Engineering Science 21
Engineering Design 0

PREREQUISITE(S): MTHE 226 (MATH 226) or MTHE 235 (MATH 235) or MTHE 237 (MATH 237) or MTHE 225 , MTHE 227 (MATH 227), ENPH 239 (PHYS 239)
EXCLUSION(S): ENPH 332 (PHYS 332), PHYS 432

ENPH 444 Advanced Quantum Physics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Perturbation theory. Scattering theory. Addition of angular momentum. Special topics: Many electron systems. Path integral formulation of quantum mechanics. Entanglement and quantum computing.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENPH 345 (PHYS 345)

ENPH 450 Deleted - Advanced Physics Laboratory and Project FW | 8

Lecture: 0
Lab: 8
Tutorial: 0
This course provides advanced physics and engineering physics students with experience in a wide range of modern experimental techniques and the design of scientific or engineering apparatus. The course is evenly divided between group projects and set experiments. Experiments incorporate measurement and design in applied physics, solid state physics, low temperature physics, nuclear physics and optics. Students spend the winter term undertaking a large group design project demonstrating their knowledge of physics and engineering. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 8
Complementary Studies 6
Engineering Science 30
Engineering Design 52

PREREQUISITE(S): PHYS 343 or ENPH 345 (PHYS 345), PHYS 350 or ENPH 351 (PHYS 351)

ENPH 453 Advanced Physics Laboratory W | 3.5

Lecture: 0
Lab: 3.5
Tutorial: 0
This course provides students in Engineering Physics with experience in a range of advanced experimental techniques and analysis. A balanced selection of experiments are performed from fields including nuclear physics, applied physics, solid state physics, low temperature physics, and optics.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 11
Engineering Science 20
Engineering Design 0

PREREQUISITE(S): ENPH 344 (PHYS 344), ENPH 345 (PHYS 345), ENPH 351 (PHYS 351) or ENPH 353
EXCLUSION(S): ENPH 450 (PHYS 450), ENPH 453 (PHYS 453)

ENPH 454 Advanced Engineering Physics Design Project F | 4.5

Lecture: 0
Lab: 4.5
Tutorial: 0
This course provides engineering physics students with a complete experience in advanced design and implementation. Working in groups, students undertake a large design project of their choice that reflects and further develops their knowledge of physics and engineering design. The students then build a prototype of their design to demonstrate the feasibility of project within the design constraints.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 14
Engineering Science 0
Engineering Design 40

PREREQUISITE(S): ENPH 354
EXCLUSION(S): ENPH 450 (PHYS 450)

ENPH 455 Engineering Physics Thesis FW | 4

Lecture: 0
Lab: 0
Tutorial: 4
Students will be assigned individual design topics of the type a practicing engineering physicist might expect to encounter. They must develop a solution under the supervision of a faculty member, and give oral and written presentations to an examining committee. Grades will be based on the quality of the analysis of the problem, the proposed solution, and the written and oral presentations. The demonstration of effective written and oral communications skills is required.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 36

PREREQUISITE(S): ENPH 351 (PHYS 351) OR ENPH 354

ENPH 456 Advanced Engineering Physics Thesis I S | 2

Lecture: 0
Lab: 0
Tutorial: 2
Students will be assigned individual research topics. Students must work under the supervision of a faculty member. Grade will be based on the progress in arriving at a solution to the assigned problem.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 10

PREREQUISITE(S): Permission of supervisor

ENPH 457 Advanced Engineering Physics Thesis II FW | 9

Lecture: 0
Lab: 0
Tutorial: 9
Continuation of ENPH 456. Upon completion of their thesis, students must give oral and written presentations to an examining committee. Grades will be based on the quality of the analysis of the problem, the proposed solution, and written and oral presentations. Demonstration of effective written and oral communications skills is required.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 48
Engineering Design 32

PREREQUISITE(S): ENPH 456
EXCLUSION(S): ENPH 455

ENPH 460 Laser Optics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Topics and applications in modern physical optics, culminating with the development of the laser and its current applications. Topics include: Gaussian beam propagation, optical resonators, Fourier optics, fiber optics, holography, light-matter interaction using classical and semi-classical

models, and the basic theory and types of lasers.

Academic Units:
Mathematics 0
Natural Sciences 21
Complementary Studies 0
Engineering Science 21
Engineering Design 0

PREREQUISITE(S): ENPH 239 (or PHYS 239), ENPH 344 (PHYS 344), or permission of the instructor
COREQUISITE(S): ENPH 431 or permission of instructor

ENPH 472 Statistical Mechanics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Phase space, the ergodic hypothesis and ensemble theory. Canonical and grand canonical ensembles. Partition functions. Ideal quantum gases. Classical gases and the liquid vapour transition. Introduction to techniques for interacting systems, including Monte Carlo simulations.

Academic Units:
Mathematics 0
Natural Sciences 31
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): ENPH 213 and ENPH 372
EXCLUSION(S): ENCH 412

ENPH 479 High Performance Computing in Engineering Physics W | 3

Lecture: 2
Lab: 0
Tutorial: 2
A course to teach students how to use the tools of high performance computing facilities, and to have them employ these tools and various common numerical algorithms in the solution of numerical physics and engineering physics projects.

Academic Units:
Mathematics 9
Natural Sciences 18

Complementary Studies 0
Engineering Science 9
Engineering Design 0

PREREQUISITE(S): ENPH 213, ENPH 344
COREQUISITE(S): ENPH 431

ENPH 480 Solid State Physics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the properties of insulators, semiconductors and metals. Topics include: crystal structure, X-ray and neutron scattering, the reciprocal lattice, phonons, electronic energy bands, and the thermal, magnetic, optical and transport properties of solids.

Academic Units:
Mathematics 0
Natural Sciences 31
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): ENPH 239 (PHYS 239), ENPH 345 (PHYS 345)
EXCLUSION(S): ENPH 380 (PHYS 380), ENPH 481 (PHYS 481)

ENPH 481 Solid State Device Physics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A course in the physics underlying solid state electronic and optical devices. The course presents an introduction to the electrical and optical properties of insulators, semiconductors and metals, including crystal structure, band theory, and electron transport. This is applied to obtain a physical understanding of the physics governing the behaviour of diodes, field effect and bipolar transistors, and other discrete optical and electronic devices.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0

PREREQUISITE(S): ENPH 239 (PHYS 239), ENPH 344 (PHYS 344)
EXCLUSION(S): ENPH 336 (PHYS 336), ENPH 380 (PHYS 380), ENPH 480 (PHYS 480)

ENPH 483 Nanoscience and Nanotechnology W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An examination of the key ideas, techniques and technologies in the fields of nanoscience and nanotechnology. Emphasis will be placed on the physics involved, measurement techniques, and technological applications. Topics covered are selected from the following: electrical and optical properties of quantum dots, quantum wires and nanotubes; quantum information technology; mesoscopic electronics; nanostructures on surfaces; and scanning-probe and optical microscopy.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0

PREREQUISITE(S): ENPH 344 (PHYS 344), ENPH 336 (PHYS 336) or ENPH 380 (PHYS 380) or ENPH 480 (PHYS 480) or ENPH 481

ENPH 487 Deleted - Surface Engineering and Analysis F | 3

Lecture: 3
Lab: 0
Tutorial: 0
An outline of the fundamental concepts and applications of modern techniques for the production and analysis of surfaces and thin films. Topics include ultra-high vacuum principles, surface thermodynamics and adsorption, electron and ion microscopy and spectroscopy, electron and x-ray diffraction, scanning probe microscopy, and growth of thin films by vapour deposition. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 8
Complementary Studies 2
Engineering Science 16
Engineering Design 10

PREREQUISITE(S): ENPH 344 (PHYS 344) or permission of the instructor

ENPH 490 Nuclear Physics F | 3.5

Lecture: 3
Tutorial: 0.5
A systematic introduction to low energy nuclear physics for advanced physics students. Lecture topics are: nucleon-nucleon forces, structure of nuclei, nuclear models, radioactivity, detection of nuclear radiation, electromagnetic, weak and strong interactions and an introduction to particle physics.

Academic Units:
Mathematics 0
Natural Sciences 42
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENPH 345 (PHYS 345)

ENPH 491 NOT OFFERED 2021-2022 Physics of Nuclear Reactors F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The fundamental physics associated with a nuclear reactor. Emphasis will be on the interaction of neutrons, reactor kinetics and calculations required in reactor design. Topics discussed include: brief review of basic nuclear physics, neutron interactions and cross-sections, neutron diffusion, neutron moderation, theory of reactors, changes in reactivity, control of reactors.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): 3rd or 4th year standing in Engineering Physics

ENPH 495 Introduction to Medical Physics W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Production and measurement of x-rays and charged particles for radiation therapy and nuclear medicine, interactions of radiation with matter and biological materials, interaction coefficients

and radiation dosimetry, radiation safety, physics of medical imaging with examples from nuclear medicine ultrasound and magnetic resonance imaging.

Academic Units:
Mathematics 0
Natural Sciences 9
Complementary Studies 0
Engineering Science 27
Engineering Design 0

PREREQUISITE(S): 3rd or 4th year standing in Engineering Physics

ENPH 555 Accelerated Engineering Physics Thesis FW | 4

Lecture: 0
Lab: 0
Tutorial: 0
Undergraduate thesis for students enrolled in the Accelerated Masters Program in Engineering Physics. They must develop an engineering solution to an assigned program under the supervision of a faculty member and give oral and written presentations to an examining committee. Grades will be based on the quality of the analysis of the problem, the proposed solution, and the written and oral presentations. The demonstration of effective written and oral communications skills is required. Students in the Accelerated Masters program are expected to work the summer before with the supervisor.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 36

PREREQUISITE(S): PREREQUISITE(S): ENPH 354 and acceptance in the Accelerated Masters Program

EXCLUSION(S): Exclusions: ENPH 455, ENPH 456, ENPH 457

Geological Engineering

GEOE 107 Deleted - History of Life F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0

The history of life, from its inception four billion years ago to the present day, focusing on the inter-relationship between organic evolution and global change. Coevolution of early life and the atmosphere; development of marine animals and their ecosystems; invasion of the land; dinosaurs and their world; mass extinctions; the Age of Mammals; and hominid evolution. Lectures plus four three-hour laboratories. COURSE DELETED in 2012-2013

Academic Units:

GEOE 207 History of Life F | 3.5

Lecture: 3
Lab: 0.5
The history of life, from its inception four billion years ago to the present day, focusing on the inter-relationship between organic evolution and global change throughout all key divisions of the Geological Time Scale used by Geological Engineers and Scientists. Coevolution of early life and the atmosphere; development of marine animals and their ecosystems; invasion of the land; dinosaurs and their world; mass extinctions; the Age of Mammals; and hominid evolution. Lectures plus four three-hour laboratories.

Academic Units:
Natural Sciences 42

GEOE 211 Deleted - Geological Engineering Field Methods F | 4.5

Lecture: 2
Lab: 2.5
Tutorial: 0
A field-based course stressing methods used in geological engineering site investigation. Includes field characterization of engineering properties and behaviour of earth materials and their structures. Student teams conduct eight site investigations that address geological engineering problems. Two of these involve the design of an infrastructure improvement project, with geological considerations. Results are presented in weekly engineering reports illustrated with maps and sections.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Science 26
Engineering Design 14

PREREQUISITE(S): APSC 151

GEOE 221 Geological Engineering Field Methods F | 5

Lecture: 3
Lab: 2
Tutorial: 0
The engineering field study of surficial deposits, rock types, and geological processes, based on the geology of the Kingston area. Descriptions, samples and measurements acquired on several field trips will be analyzed, and the results and interpretations recorded in maps, sections, and reports throughout the course.
NOTE: Field trips and laboratories are 4 hours per week. Please consult the Departmental website for more information regarding estimated field trip costs.

Academic Units:
Mathematics 0
Natural Sciences 22
Complementary Studies 16
Engineering Science 22
Engineering Design 0

PREREQUISITE(S): APSC 151

GEOE 232 Mineralogy F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Characterization of rock- and soil-forming silicate and non-silicate minerals (their crystallography, optical and physical behaviour, and crystal chemistry). The structural, chemical and genetic aspects of the crystalline state as displayed by minerals are considered. Implications of mineral properties for the engineering behaviour of soils and rocks, and for human needs, are discussed.

Academic Units:
Mathematics 0
Natural Sciences 38
Complementary Studies 0
Engineering Science 16
Engineering Design 0

PREREQUISITE(S): APSC 151

GEOE 235 Genesis and Characterization of Solid Earth Materials W | 4

Lecture: 3
Lab: 1
Tutorial: 0

Macroscopic and microscopic characterization of igneous, sedimentary and metamorphic rocks. Processes by which rocks are formed and transformed, and influence of genesis on shape, distribution, and rock-mass character of rock bodies. Engineering implications and consequences of rock-forming processes for mineral exploration and production, fossil-fuel exploration and production, and engineering site investigation.

Academic Units:
Mathematics 0
Natural Sciences 28
Complementary Studies 0
Engineering Science 20
Engineering Design 0

PREREQUISITE(S): GEOE 232 or permission of instructor

GEOE 238 Surficial Processes, Sedimentation and Stratigraphy W | 4

Lecture: 3
Lab: 1
Tutorial: 0
An examination of the genetic link between surficial geological processes and the sedimentary record produced by these processes and environments. Topics include origin of sedimentary rocks and their sedimentary structures, depositional environments, stratigraphic successions and stratigraphic principles, with a focus on their application to sedimentary basins, hydrocarbon genesis and the interaction of natural processes with human society.

Academic Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): APSC 151

GEOE 249 Geophysical Characterization of the Earth W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The application of physical principles to examine and characterize the Earth at all scales. The Earth's physical properties and dynamic processes will be assessed and evaluated by integrating such topics as gravity, seismology, magnetism, geochronology, and heat flow, as related to scientific and engineering problems.

Academic Units:
Mathematics 12
Natural Sciences 12
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): APSC 111 and APSC 151 and APSC 171and APSC 172 , or permission of instructor

GEOE 262 Geological Aspects of Mineral Deposits W | 3.75

Lecture: 3
Lab: 0.75
Tutorial: 0
The basic mineralogy and petrology of mineral deposits are examined. The formation and classification of mineral deposits, considering such aspects as tectonic setting, age, rock composition, geometry, and mineralogy are investigated. Emphasis is placed on the processes by which mineral deposits are formed and transformed, and their influence on mining and production. Laboratory work integrates geological information from the scale of hand samples to regional maps as tools to assist with mine design, estimation of ore grade and evaluation of issues related to ore processing.

Academic Units:
Mathematics 0
Natural Sciences 20
Complementary Studies 0
Engineering Science 25
Engineering Design 0

PREREQUISITE(S): APSC 151 or equivalent
EXCLUSION(S): GEOE 232 (GEOL 232),GEOE 235 (GEOL 235) GEOE 362 (GEOL 362)

GEOE 281 Introduction to Geological Engineering F | 3.5

Lecture: 2.5
Lab: 0
Tutorial: 1
Introduction to all of the integrated fields of Geological Engineering and the essence of engineering design in an earth-systems context. Focus is on geological engineering properties and processes and their impact on design, with a particular focus on scale dependency, natural variability and risk-assessment. Introductory geotechnical engineering, applied geophysics, resource engineering, hydrogeology and geo-environmental engineering is highlighted with

emphasis on the following: mining related site investigation and design, tunnelling, infrastructure development, natural-hazard mitigation and environmental remediation and resource exploration and management. A one day field trip is required

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): APSC 151 , or permission of the instructor
COREQUISITE(S): GEOE 221, or permission of the instructor

GEOE 282 NOT OFFERED THIS YEAR - Earth Systems Engineering II: Resources and Environment W | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
An earth-system engineering perspective on the nature and acquisition of energy, mineral and water resources, with particular emphasis on the environment considerations in their extraction, processing, and use. Criteria for designing resource exploration programmes are examined. Practical exercises, projects and seminars (team and individual) deal with these issues, and include the design of risk-management plans, environmental life-cycle assessments, sustainable systems, and ore-reserve estimations.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 18
Engineering Design 12

PREREQUISITE(S): GEOE 232 and GEOE 221, or permission of the instructor

GEOE 300 Geological Engineering Field School F | K4

Lecture: yes
Lab: yes
Tutorial: yes
An intensive one-week course taken at the end of August before the start of third year. Teams of students design and implement a geological engineering field investigation program to produce and interpret geological field maps.

NOTE: The cost of accommodation, transportation and food will be borne by the student. Please consult the Departmental website for more information regarding estimated field trip costs.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): GEOE 221 and GEOE 235 and GEOE 238 and GEOE 281, or permission of instructor

GEOE 301 Field Studies in Geology F | 1.5

Lecture: 0
Lab: 1.5
Tutorial: 0
A multi-day field trip that uses stratigraphic, sedimentological, and paleontological data to interpret rock successions in a paleoenvironmental and tectonic context. Enrolment is limited. NOTE: The course runs during the week of Canadian Thanksgiving. Students are responsible for the cost of transportation, accommodation and food during the trip. Please see the Departmental web page for more information

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): GEOE 238 and permission of instructor
COREQUISITE(S): GEOE 321 or GEOE 337 or GEOE 368

GEOE 310 Deleted - Geological Engineering Field School |

An intensive two-week course taken immediately after final examinations in second year. Teams of students apply geological field methods and geological engineering assessment techniques learned during second year, as the basis for an engineering assessment of overburden and bedrock for a suite of specific engineering design outcomes. These outcomes include mineral resource evaluation, mine design, geotechnical stability and environmental baseline assessment related to future engineering works. In addition the students are expected to optimize the design of their own site investigation program to maximize the practical value of information obtained. A final site investigation and engineering report, including design solutions for the aforementioned problems, is presented and defended. Field safety regulations and safe practice are emphasized. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 45

PREREQUISITE(S): GEOE 211 (GEOL 211) and GEOE 235 (GEOL 235), or permission of the instructor.

GEOE 313 Engineering Geology and Geomechanics W | 3.5

Lecture: 2.5
Lab: 1
Tutorial: 0
Application of geomechanical principles to rock characterization, engineering analysis and design problems related to surface and underground construction in rock and surface slope stability. Presentation and discussion of geomechanics theory, including stress, strain, strength of materials and post yield behaviour, and analysis tools with application to typical rock engineering problems and to case histories involving empirical, analytical and numerical solutions. Emphasis on the inherent variability of geomaterials at the lab and field scale and implications for design.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 22
Engineering Design 20

PREREQUISITE(S): APSC 151, APSC 174, CIVL 230, GEOE 321 (or CIVL 340), and GEOE 359 (or CIVL 222) , or permission of the instructor.
EXCLUSION(S):

GEOE 319 Applied Geophysics W | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
Geophysical tools and methods (including gravity, magnetic, electrical, and seismic) applied to

engineering problems, including resource exploration and site investigation. Design of field programs using these methods including consideration of physical principles, instrumentation, field procedures and data interpretation.

Academic Units:
Mathematics 12
Natural Sciences 18
Complementary Studies 0
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): GEOE 249, MTHE 232 or (MTHE 225), or permission of instructor
COREQUISITE(S): GEOE 359

GEOE 321 Analysis of Rock Structures F | 4

Lecture: 2.75
Lab: 1.3
Tutorial: 0
Characterization and analysis of rock deformation and fracture at all scales. Topics include geometric, kinematic and dynamic analysis of rock structure, mechanics of rock deformation (stress and strain), geologic mapping and map interpretation with applications to earth resource exploration and exploitation, mining, geohazards and geotechnical engineering. Introduction to geotectonics with examination of selected tectonic associations. Required full-day field trip.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 24
Engineering Design 0

COREQUISITE(S): GEOE 300 or permission of the instructor

GEOE 323 Deleted - Quaternary Glacial Geology |

Quaternary paleoclimates and ice ages. Glacial and proglacial processes, environments and landforms. Dating techniques. Glacial interglacial history and stratigraphy of selected areas in Canada. One or more one-day field trips may be required. Offered next in 2012/13, and every second year thereafter. COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 35

Complementary Studies 0
Engineering Science 13
Engineering Design 0

PREREQUISITE(S): GEOE 238 (GEOL 238) or permission of the instructor

GEOE 333 Terrain Evaluation W | 4

Lecture: 3
Lab: 1
Tutorial: 0
An introduction to the principles of geomorphology relevant to site investigation and analysis for Geological Sciences and Geological Engineering. An emphasis is made on the evaluation of terrain features using analog and digital imagery using traditional and digital (GIS) methods and on terrain analysis using computational methods, generation of surface models from LiDAR and imagery, and integration into simulations. Applications include engineering investigation of geohazards, earth resources and infrastructure engineering.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): APSC 151 or permission of the instructor

GEOE 337 Paleontology F | 3.75

Lecture: 2.75
Lab: 1
Tutorial: 0
Review of the major groups of invertebrate fossils, emphasizing morphology, taxonomy and geological significance; introduction to paleoecology and biostratigraphy; analysis of major trends and processes in organic evolution.

Academic Units:
Mathematics 0
Natural Sciences 45
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): GEOE 238 or permission of instructor

GEOE 340 Problems in Geological Engineering F/W | 3

Lecture: 0
Lab: 0
Tutorial: 3
Each student investigates a problem in geological engineering that is not covered in any of the available courses, and submits a written report on the topic. This course is open to students only if a suitable faculty member is available.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year Geological Engineering and permission of designated instructor

GEOE 341 Special Topics in Applied Geology F/W/S | 3

Lecture: 0
Lab: 0
Tutorial: 3
This course provides intensive coverage of a special topic in applied geology and will be offered periodically and may be presented by faculty or by visiting professionals. Consult the department homepage for opportunities.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year Geological Engineering and permission of designated instructor

GEOE 343 Applied Hydrogeology F | 3.5

Lecture: 2.5
Lab: 0
Tutorial: 1

Development of the equations governing flow and transport and interpretation of fundamental hydrogeological properties. Site conceptualization, sensitivity to subsurface complexities will be discussed along a variety of field techniques, instrumentation, and sampling protocols. Interpretation of hydrogeological data will take place in the context of groundwater occurrence and flow system analysis, engineering geology and geotechnical applications, as well as groundwater contamination. Case studies and practical applications are presented by visiting hydrogeologists

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 16

PREREQUISITE(S): Completion of 2nd year Geological Engineering, or permission of designated instructor.

GEOE 345 Site Investigation & Geological Engineering Design W | 4

Lecture: 3
Lab: 1
Tutorial: 0
The course involves a team approach to tackling current geological engineering problems and developing innovative design solutions. Critical site investigation and site selection decisions are proposed, undertaken and tested with consideration of "downstream" engineering issues and constraints. The course relies on student consultation with guest participants, most of whom are practicing professional engineers. Additionally, topics such as professional liability and ethics, equity, environmental legislation, and the Occupational Health and Safety Act are presented and discussed. Formalized engineering design tools including FMEA, QRA will be utilized. Course includes a major geological engineering design project involving technical concepts, key elements of project management and communication of proposed design solutions.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 16
Engineering Science 0
Engineering Design 32

PREREQUISITE(S): Completion of 2nd year Geological Engineering, or permission of instructor

GEOE 349 Deleted - Applications of Quantitative Analysis in Geological Engineering W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A course in the application of quantitative mathematical methods to solve a variety of geological engineering problems. The utility, significance, and widespread applicability of analytical and numerical techniques will be illustrated in the evaluation and solution of practical problems taken from environmental science, geology, geohydrology, and geophysics. COURSE DELETED 2012-2013

Academic Units:
Mathematics 8
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 10

PREREQUISITE(S): APSC 142, GEOE 249 (GEOL 249), MTHE 227 (MATH 227), MTHE 226 (MATH 226) or MTHE 232 (MATH 232),

GEOE 359 Applied Quantitative Analysis in Geological Engineering F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
The theory and use of numerical computational procedures to solve geo-engineering problems. The utility, significance and widespread applicability of analytical and numerical techniques will be illustrated in the evaluation and solution of practical problems. Methods for: solution of simultaneous linear equations, curve fitting, solution of the algebraic eigenvalue problem, interpolation, least-squares, error propagation and geostatistics are included.

Academic Units:
Mathematics 15
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 12

PREREQUISITE(S): GEOE 249 and MTHE 225 (or MTHE 232) and APSC 174 and APSC 143 or MNTC 313 or permission of instructor
COREQUISITE(S): CHEE 209
EXCLUSION(S): MTHE 272

GEOE 362 Resource Engineering W | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Characterization of major ore deposit types using petrological, geochemical and geophysical engineering sciences, including tectonic setting, age, rock composition, geometry, mineralogy and textures, geochemical and geophysical signatures of mineral deposits. Design involves evaluation of ore deposit models and exploration programs, including ore processing and environmental issues. Laboratory work integrates investigation of mineral deposit's samples to determine paragenetic sequences, estimation of ore grade and evaluation of issues related to ore processing and site contamination.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Science 25
Engineering Design 15

PREREQUISITE(S): GEOE 221 and GEOE 235 and GEOE 321 and GEOE 365, or permission of the instructor
EXCLUSION(S): GEOL 382 , GEOE 262

GEOE 365 Geochemical Characterization of the Earth F | 4

Lecture: 3
Lab: 1
Tutorial: 0
The application of thermodynamics and kinetics to the understanding of geological processes in the Earth Sciences. Distribution of the elements, and practical uses of isotopes and elemental tracers. Geochemical actions and transactions within, and among, the lithosphere, hydrosphere, atmosphere and biosphere, including the impact of human evolution and environmental geochemistry. Practical application of geochemistry to solving problems in natural systems will be emphasized. A practical involving problems, laboratory experience and field experience will be part of the course.

Academic Units:
Mathematics 0
Natural Sciences 27
Complementary Studies 0
Engineering Science 21
Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132, GEOE 235, or permission of the instructor

GEOE 368 Carbonate Sedimentology F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
The origin, composition and diagenesis of carbonate rocks. Study of modern carbonate sediments and depositional environments; development and design of facies models; petrographic and geochemical analysis of limestones and dolostones.

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): GEOE 238 or permission of the instructor

GEOE 401 Field Studies in Geology II F | 1.5

Lecture: 0
Lab: 1.5
Tutorial: 0
A multi-day field trip that uses stratigraphic, sedimentological, paleontological, and structural data to interpret shallow-and deep-marine rock successions in a paleoenvironmental and tectonic context. Enrollment is limited. NOTE: The course runs during the week of Canadian Thanksgiving. Students are responsible for the cost of transportation, accommodation and food during the trip. Please see the Departmental web page for more information.

Academic Units:
Mathematics 0
Natural Sciences 9
Complementary Studies 0
Engineering Science 9
Engineering Design 0

PREREQUISITE(S): (A minimum GPA of 2.90 in each of GEOE 221, GEOE 238 and GEOE 321) and permission of the Department.
COREQUISITE(S): GEOE 488

GEOE 402 Deleted - Exploration and Mining Geology Field School (two weeks) |

A two-week, intensive field course. Design and application of field data collection methods in exploration and mining projects, and in environment site remediation. Elements of design include: surface mapping and underground surveying in mining camps, drill core logging, determination of geological properties, 3D geological projections, integration of scientific literature and mining industry reports. Production of a final report with design solutions. Offered next in Spring 2010. Students should consult with course instructors regarding field trip costs. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 10
Engineering Design 50

PREREQUISITE(S): GEOL 300 or GEOE 310 (GEOL 310), and GEOE 362 (GEOL 362), or permission of the instructor

GEOE 403 Deleted - Geotechnical and Geo-Environmental Field School F | 3

Lecture: 0.5
Lab: 2
Tutorial: 0.5
Technical discussions and working tours of sites involving exposure to major geotechnical and geoenvironmental design projects in various stages of development, with a focus on mining engineering, mine waste management and civil engineering works. The key geological engineering and design issues associated with each project are examined, from preliminary engineering design through engineering control of construction through long-term monitoring and maintenance. Students evaluate current design issues and develop engineering design solutions which are presented in the form of engineering reports and presentations. Preference given to students in the G5 and G6 Options.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 6
Engineering Design 30

PREREQUISITE(S): GEOE 281 (GEOL 281), GEOE 310 (GEOL 310)

GEOE 409 Deleted - Applied Geophysics: Laboratory F | 5

Lecture: 1
Lab: 1.5
Tutorial: 2.5

Local field exercises and laboratory assignments using a wide variety of geophysical site-investigation and exploration methods. Lectures will be used to teach basic instrument theory, and to teach the principles of exploration program design. The course includes a four-day field exercise to design and carry out an integrated geophysical site investigation. Evaluation is based on submitted technical reports arising from the practical assignments. Offered next in 2010/11. Students should consult with course instructors regarding estimated field trip costs.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 42

PREREQUISITE(S): GEOE 319 (GEOL 319) or permission of the instructor

GEOE 410 NOT OFFERED 2021-2022 Geological Engineering Field School F | K4

Lecture: YES
Lab: YES
Tutorial: YES
A one week intensive field course with associated discussions and project work during the term. Design and application of field data collection methods in exploration and mining projects, underground and surface mine works and for site remediation.. The key geological engineering and design issues associated with each project are examined, from preliminary engineering design through engineering control of construction through long-term monitoring and maintenance. Students evaluate current design issues and develop engineering design solutions which are presented in the form of engineering reports and presentations.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 12

PREREQUISITE(S): Completion of 3rd year Geological Engineering

GEOE 413 Rock Engineering Design F | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
Rigorous application of geomechanics and rock engineering principles to open-ended design

problems related to surface and underground excavation, construction and geo-hazard mitigation. Student-led projects will compliment presentation and discussion of design methodologies and case histories are followed up by related analysis and design problems incorporating industry standard software. Emphasis on the inherent variability of geomaterials and implications for integrated site-investigation planning, quantitative risk assessment, design decision-making and performance-monitoring. A field excursion will be included.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 30

PREREQUISITE(S): GEOE 281and GEOE 300 and GEOE 313 and GEOE 321 and GEOE 359, or permission of the instructor

GEOE 414 Foundations of the Oil and Gas Industry W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Fundamentals of the oil and gas industry covering Chemical Engineering and Geological Engineering practice, and implications of Canadian and world political forces together with business practices are covered. Industry needs for exploration, recovery, processing, business expansion and policy issues will be addressed through case studies, in conjunction with examination of suitable business models. (0/0/0/30/12)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

GEOE 418 Petroleum Geology F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
The origin, migration and accumulation of petroleum resources, emphasizing typical reservoir styles, potential reservoir lithologies, methods of exploration and basic concepts of formation evaluation. Concepts and applications equip students with the basic principles necessary to

undertake petroleum industry exploration and production. Laboratory exercises include a major exploration design problem and presentation.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 30
Engineering Design 0

PREREQUISITE(S): GEOE 238
COREQUISITE(S): GEOE 321

GEOE 419 Engineering Geophysics Field School F | K4

Lecture: YES
Lab: YES
Tutorial: YES
This nine day, intensive, tri-university field course focuses on field and laboratory techniques using a wide array of geophysical site investigation and exploration methods. Lectures are used to review basic instrument theory, and to teach the principles of exploration program design. The course culminates in an exercise to design and implement an integrated geophysical site investigation. Course takes place before start of 4th year. Students should consult with departmental website regarding estimated field trip costs.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 12

PREREQUISITE(S): Completion of 3rd year Geological Engineering or permission of the instructor.

GEOE 421 Deleted - Igneous Petrology |

Rock classification and tectonic associations, petrochemistry, petrogenesis, the origin and differentiation of primary magmas, plate tectonics and magmatic evolution. Phase diagrams of igneous minerals. Laboratory study of rock suites and special projects. Offered next in 2011/12, and every second year thereafter. COURSE DELETED 2014-2015

Academic Units:
Mathematics 0

Natural Sciences 30
Complementary Studies 0
Engineering Science 12
Engineering Design 0

PREREQUISITE(S): GEOE 235 (GEOL 235) or GEOL 335

GEOE 422 Deleted - Metallogeny and Mineral Exploration |

Integration of geological, mining and metallurgical engineering, economic, political, social and environmental issues, and application of ore deposit modeling and geophysical and geochemical exploration methods, in the design of comprehensive exploration programs for the discovery and development of Earth materials in an economic and environmentally responsible manner. Offered next in 2014/15, and every second year thereafter. COURSE DELETED 2014-2015

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 28

PREREQUISITE(S): GEOE 362 or permission of the instructor
COREQUISITE(S): GEOE 362 or permission of the instructor

GEOE 429 Deleted - Geophysical Signal Analysis and Inverse Theory W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Underlying theory and guiding principles of digital geophysical data collection and processing system design. Discrete Fourier and sampling theory; filter poles and zeros, signal shaping, least-squares and prediction filters; causality implications. Applications to processing of potential field map data and waveform time series. Theory and practice of geophysical inversion culminating in the design and construction of optimized quantitative Earth models. Discrete linear problems, maximum likelihood, Lanczos decomposition, uniqueness and accuracy. Nonlinear problems from seismic imaging. Offered next in 2009-2010, and every second year thereafter. COURSE DELETED 2012-2013

Academic Units:
Mathematics 6
Natural Sciences 7
Complementary Studies 0
Engineering Science 21

Engineering Design 8

PREREQUISITE(S): MTHE 338 (MATH 338) and GEOE 319 (GEOL 319), or permission of the instructor

GEOE 439 Advanced Applied Geophysics F | K3

Lecture: yes
Lab: yes
Tutorial: yes
Advanced theory and techniques for acquisition, processing and interpretation of geophysical data. Students solve a geophysical problem from the initial idea through strategy development, data acquisition, processing, to interpretation, communication and deliverables. Engineering projects will exploit seismic, gravity, magnetic, electromagnetic, geodetic and GPR techniques but the emphasis is on problem solving using integrated data from multiple methods/sources. Target areas include oil/gas/mineral exploration, near-surface prospecting and site investigation. Processing will use both available and student designed software.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): MTHE 232 (or MTHE 225) and GEOE 249 and GEOE 319 or permission of instructor

GEOE 445 Deleted - Site Investigation and Case Histories F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
The course provides an overview of current geological engineering problems and innovative solutions, and relies on guest speakers, most of whom are practicing professional engineers. Topics such as professional practice and liability, engineering ethics, provincial and national environmental legislation, and the Occupational Health and Safety Act are presented and discussed. Guest lecture topics may include: buying and selling professional services, water supply management, contaminant abatement and/or remediation, management of engineering construction. Starting in Fall 2009, a one-day field exercise in engineering surveying methods will be held early in the term. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 7
Engineering Science 5
Engineering Design 30

PREREQUISITE(S): Completion of third-year common core for GEO ENG, or permission of the instructor

GEOE 446 Engineering Design Project I F | K4

Lecture: yes
Lab: yes
Tutorial: yes
Student teams research, prepare a design work plan and carry out a "Phase 1" engineering investigation for a major, open-ended geological engineering project, in consultation with a Management Board comprising geological engineering faculty. Work plans adhere to current national and/or provincial regulations as appropriate, and include scope definition, development of a range of technical solutions to the engineering problem, cost analyses and project scheduling tasks. Design meetings are recorded in the form of minutes submitted to the course Management Board and time sheets are submitted. Engineering project work plans are presented and defended to a committee comprising faculty and external engineers. Evaluation is based on the presentation and the team-written preliminary design report. These reports form the basis for more in depth design work in GEOE 447 in the winter. Students must register in both GEOE 446 and GEOE 447.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 48

PREREQUISITE(S): Completion of 3rd year Geological Engineering

GEOE 447 Engineering Design Project II W | K5.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
Student teams carry out design work, including detailed analysis, synthesis, and presentation for the open-ended engineering projects proposed and initiated in GEOE 446. Projects adhere to current national and/or provincial regulations as appropriate, and include further development of engineering solutions while controlling project schedule, budget and critical path design objectives. Data are obtained from industrial sources, government documents, engineering

reports, the appropriate literature, and field studies and testing. Design projects, including methodologies, budgeting and technical components will be defended in class to a committee. Evaluation is based on two presentations and the team-written design report. Students must register in both GEOE 446 and 447.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 66

PREREQUISITE(S): GEOE 446

GEOE 452 Instrumental Techniques Applied to the Study of Solids W | 3

Lecture: 2
Lab: 1
Tutorial: 0
The theory and practical aspects of the techniques of X-ray powder diffraction and scanning electron microscopy are studied. Other techniques including Mossbauer, infra-red spectroscopy, and nuclear magnetic resonance spectroscopy will also be covered. An extensive term project is required where the student employs these techniques to study a material of their choice. This course may not be offered every year.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 12
Engineering Design 0

PREREQUISITE(S): GEOE 232 or permission of the Instructor

GEOE 462 Advanced Petrogenesis and Metallogenesis W | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Application of the fundamental principles of igneous petrology, geochemistry and fluid-rock interaction to metallogeny and ore genesis. Training in ore microscopy and mineral paragenesis with mineral chemistry and lithogeochemical data for selected case studies. Lectures, critical reading, discussion sections, laboratory work and seminars will provide an understanding of ore forming processes.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Science 30
Engineering Design 10

PREREQUISITE(S): GEOE 362 and GEOE 365 or permission of instructor

GEOE 463 Spatial Information Management in the Geosciences F | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
An introduction to spatial information management focusing on methods to support and extend geological mapping, mineral and petroleum exploration, and engineering site investigation. Computers and computation, GIS software and theory, spatial simulation and analysis, databases and data management, and design of effective decision support solutions.

Academic Units:
Mathematics 14
Natural Sciences 0
Complementary Studies 0
Engineering Science 28
Engineering Design 0

PREREQUISITE(S): GEOE 333 or permission of the instructor
EXCLUSION(S): GISC 201

GEOE 464 Visualization in Geosciences W | 1.5

Lecture: 1
Tutorial: 0.5
An introduction to 3D visualization of natural sciences data with a focus on methods relevant to geological engineering, mineral exploration, and geoscience research. Perception, representation, and analytical methods. Design tools and data integration methods. Temporal analysis of natural sciences data. LiDAR data analysis. Global and local models. Virtual worlds.

Academic Units:
Engineering Science 18
PREREQUISITE(S): GEOE 463 or permission of instructor

GEOE 465 Deleted - Exploration Geochemistry W | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
Principles of geochemistry in mineral exploration, and the use of geochemistry in tracing specific paleohydrologic flow in complex, multicomponent media in systems that deposit ores. Primary and secondary dispersion and their significance in geochemical exploration. Selected case histories. Field and analytical techniques, and interpretation of geochemical data. Design of exploration programs. COURSE DELETED 2012- 2013

Academic Units:
Mathematics 0
Natural Sciences 16
Complementary Studies 0
Engineering Science 26
Engineering Design 0

PREREQUISITE(S): GEOL 362 or permission of instructor

GEOE 466 Isotopes and the Environment W | 4

Lecture: 3
Lab: 1
Tutorial: 0
This course is designed to expose advanced students in the fields of biology, chemistry, geography or geology to the principles of stable isotope and radiogenic isotope systematics in natural processes. Emphasis will be placed on the use of isotopes in tracing elemental cycles, biological cycles and hydrologic cycles and how some isotopes can be used to place constraints on the timing of specific events in these cycles.

Academic Units:
Mathematics 0
Natural Sciences 48
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): GEOE 365 or permission of the instructor

GEOE 475 Exploration and Environmental Geochemistry F | 4.3

Lecture: 2.75
Lab: 1.8
Tutorial: 0
Principles of rock-water interaction and element migration in the near surface environment

applied to environmental and exploration geochemistry. Students learn field and analytical techniques, evaluate and interpret geochemical data, and design solutions related to geochemical hazards to human health, environmental impacts of mining, and formulation of strategies for detecting mineral deposits.

Academic Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): GEOE 365 or permission of the instructor

GEOE 478 Terrigeneous Clastic Sedimentology F | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
Detailed examination of depositional processes and external controls on the facies organization and sequence stratigraphy of fluvial, coastal, shelf, and deep-marine environments. Introduction to sedimentary basin types.

Academic Units:
Mathematics 0
Natural Sciences 26
Complementary Studies 0
Engineering Science 16
Engineering Design 0

PREREQUISITE(S): GEOE 238 or permission of the instructor

GEOE 481 Structural Analysis Applied to Resource Deposits W | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
Applications of the principles of rock deformation to the fabric analysis of rocks in the optimization of strategies for open-ended resource exploration, resource engineering and geotechnical engineering problems. Emphasis is on fracture, fault, and vein analysis; structures in fold and thrust belts; and studies of superposed deformation and their impact on effective and economical mineral resource development. Offered next in 2011/12, and every second year thereafter.

Academic Units:
Mathematics 0
Natural Sciences 20
Complementary Studies 0
Engineering Science 22
Engineering Design 0

PREREQUISITE(S): GEOE 321 or permission of the instructor

GEOE 485 Deleted - Environmental Aqueous Geochemistry W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Examination of rock-water interaction, and the geological controls on the chemical evolution and anthropogenic modification of surface- and ground-water, as applied to environmental problems. Application of thermodynamics, activity diagrams, and computer models in the design of assessment systems and mitigation schemes for problems of water contamination. Students evaluate, and design solutions related to, case studies in the areas of geochemical hazards to human health and the environmental impacts of mining, including acid mine drainage. Offered next in 2011/12, and every second year thereafter. COURSE DELETED IN 2012/2013 ~

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): GEOE 232 (GEOL 232) or permission of the instructor

GEOE 488 Geology of North America F | 3

Lecture: 3
Lab: 0
Tutorial: 0
An advanced course discussing the principles of earth evolution as exemplified by North America. The holistic approach illustrates the way in which integrated geodynamics, geochemistry, sedimentation, paleobiology and oceanography are used to unravel the history of the continent.

Academic Units:
Mathematics 0
Natural Sciences 24

Complementary Studies 0
Engineering Science 12
Engineering Design 0

PREREQUISITE(S): Completion of 3rd year Geological Engineering or permission of the instructor
COREQUISITE(S): Fourth Year Geological Engineering or permission of the instructors

Geology

GEOL 382 Deleted - Resource Engineering F |

Lecture: 33
Lab: 15
Tutorial: 0
Characterization of major ore deposit types using petrological, geochemical and geophysical engineering sciences, including tectonic setting, age, rock composition, geometry, mineralogy and textures, geochemical and geophysical signatures of mineral deposits. Design involves evaluation of ore deposit models and exploration programs, including ore processing and environmental issues. Laboratory work integrates investigation of mineral deposit's samples to determine paragenetic sequences, estimation of ore grade and evaluation of issues related to ore processing and site contamination. COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 21
Engineering Design 15

PREREQUISITE(S): GEOL 235, GEOL 281 or permission of the instructor.
EXCLUSION(S): GEOL 362

Geographic Information Science

GISC 201 DELETED - Geographic Information Science W | 3

Lecture: 2
Lab: 1
Tutorial: 0
An introduction to the basic principles, techniques, and practical issues in assessing, accessing, and maintaining data sources and database systems and related tools for the manipulation and analysis of data. Students will learn concepts of database management and computer programming and will apply these concepts to the preparation, manipulation, analysis, and

presentation of spatial and tabular data. Deleted 2016-2017

Academic Units:
Mathematics 4
Natural Sciences 16
Complementary Studies 6
Engineering Science 4
Engineering Design 6

PREREQUISITE(S): Completion of the First Year Applied Science Program or permission of the Department of Geography

GISC 202 DELETED - Data Collection, Management and Analysis W | 4

Lecture: 4
An introduction to the theory, methods, and practical issues in assessing, accessing, and maintaining data sources and database systems and related tools for the manipulation and analysis of data. Students will learn concepts of database management and computer programming and will apply these concepts to the preparation, manipulation, analysis, and presentation of spatial and tabular data. Deleted 2016-2017

Academic Units:
Mathematics 5
Natural Sciences 20
Complementary Studies 10
Engineering Science 5
Engineering Design 8

PREREQUISITE(S): Completion of the First Year Applied Science Program or permission of the Department of Geography

GISC 301 DELETED - Spatial Analysis F | 3

Lecture: 2
Lab: 1
Tutorial: 0
An in-depth exploration of the spatial analysis techniques used in vector GIS. The analysis of geographic primitives of points, lines, areas and surfaces in the context of applications drawn from geography, biology, planning and related disciplines. Emphasis is placed on the use of current GIS software in a hands-on environment. Deleted 2016-2017

Academic Units:
Mathematics 4
Natural Sciences 16

Complementary Studies 6
Engineering Science 4
Engineering Design 6

PREREQUISITE(S): GISC 201 or GISC 202 or GEOE 463 (GEOL 463) or permission of the Department of Geography

GISC 302 DELETED - Environmental Modelling W | 3

Lecture: 2
Lab: 1
Tutorial: 0
Study of the techniques of Geographic Information Systems and their applications in solving physical and environmental problems. Topics include data representation and models, spatial interpolation, raster-based analysis and modelling, surface models and terrain analysis, data visualization, temporal analysis, error and accuracy, and other algorithms and analytical procedures. Deleted 2016-2017

Academic Units:
Mathematics 4
Natural Sciences 16
Complementary Studies 6
Engineering Science 4
Engineering Design 6

PREREQUISITE(S): GISC 201 or GISC 202 or GEOE 463 (GEOL 463) or the permission of the Department of Geography

GISC 303 DELETED - Application Design and Customization in GIS F | 3

Lecture: 2
Lab: 1
Tutorial: 0
An introduction to customization of GIS and database software with an emphasis on spatial analysis tool development for desktop and Web-based GIS. Students will learn concepts of user requirements analysis, software requirements preparation, interface and software design, and computer programming while they develop customized GIS applications. Deleted 2016-2017

Academic Units:
Mathematics 4
Natural Sciences 16
Complementary Studies 6
Engineering Science 4
Engineering Design 6

PREREQUISITE(S): GISC 201 or GISC 202 or GEOE 463 (GEOL 463) or permission of the Department of Geography

Geography

GPHY 304 Arctic and Periglacial Environments W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Advanced study of the physical geography of northern regions, emphasizing the Canadian Arctic.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 12
Engineering Design 0

Microbiology

MBIO 218 NOT OFFERED THIS YEAR-Gene Structure and Function (Molecular Biology) W | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
Molecular mechanisms of gene expression, biochemistry of nucleic acids, chromatin structure, DNA replication, RNA transcription, processing and translation in prokaryotic, eukaryotic and viral systems. Offered jointly by the Departments of Biochemistry, Biology and Microbiology and Immunology.

Academic Units:
Mathematics 0
Natural Sciences 39
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): BIOL 205

Multi-department Courses

MDEP 221 Deleted - Engineering and Social Justice: Critical Theories of Technological Practices W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course is intended to help students understand critical theories and to develop critical perspectives towards technology in general and engineering practices in particular and draws from sociology, history, political economics, science and technology studies and philosophy. The course is cross-disciplinary in its approach and will explore the relationship between technology, labour, industry, society, and the natural world. Students will reflect on notions of rights, justice, freedom and sustainability in human and non human arenas.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

EXCLUSION(S): SOCY 234

MDEP 437 DELETED-Fuel Cell Technology F |

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction to and history of various fuel cell systems. Fuel cell fundamentals including thermodynamics, electrode kinetics, fuel cell performance and transport issues. Systems covered include Polymer Electrolyte Membrane (PEMFC), Direct Methanol (DMFC), Alkaline (AFC), Solid Oxide (SOFC), and Molten Carbonate (MCFC). Fueling processing issues and combined heat and power systems. Overview of the current fuel cell industry. This course is offered by the Department of Chemical Engineering and the Department of Mechanical and Materials Engineering. April 2018

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21

Mechanical Engineering

MECH 202 Mathematical and Computational Tools for Mechanical Engineers I F | K3.5

Lecture: Yes
Lab: No
Tutorial: Yes
This course will provide students with an introduction to vector calculus, analytical, and numerical solution methods for ordinary differential equations. The topics of the course will be presented through problems, models and applications relevant to the Mechanical Engineering Program. On completion of the course students will be able to: manipulate vectors; perform numerical integration; solve first- and higher-order ordinary differential equations analytically and numerically. Students will solve problems analytically and computationally in an active learning, tutorial environment.

Academic Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 143 or MNTC 313, APSC 171, APSC 172 and APSC 174
EXCLUSION(S): MTHE 225, MATH 225 and MTHE 272

MECH 203 Mathematical and Computational Tools for Mechanical Engineers II W | K3.5

Lecture: Yes
Lab: No
Tutorial: Yes
This course will introduce numerical and statistical methods for the solution of engineering problems, to complement those discussed in MECH 202. The topics of the course will be presented through problems, models and applications relevant to the Mechanical Engineering Program. On completion of the course students will be able to: solve linear systems of equations; analyze random processes; perform local optimization and hypothesis testing; interpolate and fit discrete data sequences. Students will solve problems analytically and computationally in an active learning, tutorial environment. The course will include a design project.

Academic Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 11

PREREQUISITE(S): MECH 202
EXCLUSION(S): MTHE 225, MATH 225 and MTHE 272

MECH 210 Electronic Circuits and Motors for Mechatronics W | K4.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
This introductory course for mechanical engineering students begins with a review of the concepts of resistance, capacitance, and inductance. Circuit analysis techniques are then applied to characterize the behaviour of commonly used mechatronic circuits including devices such as transformers, diodes, solenoids, DC motors and actuators. Transistors are introduced in switching applications. Selection and testing of electric motors and drivers/controllers for stationary and mobile mechanical applications. Lab activities will focus on design, construction, and testing of microcontroller based mechatronic systems for practical applications, building on skills typically developed in MECH 217. Students will solve mechatronics problems analytically and computationally in an active learning, tutorial environment.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 40
Engineering Design 14

PREREQUISITE(S): APSC 111, APSC 112, APSC 171, APSC 172, and APSC 174
EXCLUSION(S): ELEC 210, ELEC 221

MECH 211 Manufacturing Methods F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The objective of this course is to achieve a knowledge and understanding of a wide variety of manufacturing processes involving plastics and metals. This course forms the basis for improved product and machine design, and will assist the mechanical engineer to function in the areas of design, manufacturing and general engineering. Training in the use of machine and welding tools found in a modern job shop is a required activity practiced in the machine tool laboratory in MECH 212.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Science 28
Engineering Design 14

EXCLUSION(S): MECH 213

MECH 212 Machine Tool Laboratory F/W | 1.0

Lecture: 0
Lab: 1
Tutorial: 0
Training in the use of machine and welding tools found in a modern job shop is a required activity practiced in the machine tool laboratory in this course. - COURSE DELETED 2012-2013
New course then created during COVID 2020 but seven years later as new title and description.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 8
Engineering Design 4

EXCLUSION(S): MECH 213

MECH 213 NOT OFFERED 2021-2022 Manufacturing Methods F | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
The objective of this course is to achieve a knowledge and understanding of a wide variety of manufacturing processes involving plastics and metals. This course forms the basis for improved product and machine design, and will assist the mechanical engineer to function in the areas of design, manufacturing and general engineering. Training in the use of machine and welding tools found in a modern job shop is a required activity practiced in the machine tool laboratory. NOTE: It is highly advised that MME students take MECH 270 concurrently with this course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 18

EXCLUSION(S): MECH 211, MECH 212

MECH 215 DELETED-Instrumentation and Measurement F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course presents techniques and devices for measurements in mechanical systems of solids and fluids. On completion of the course, students will be able to: Identify and Quantify measurement objectives in practical engineering applications; Apply statistical analysis, including uncertainty for interpreting test results; Specify and Select transducers, acquisition systems, and procedures to measure temperature, pressure, stress, strain and force; position, velocity and acceleration; Apply physical principles to predict static and dynamic system performance for pressure, strain, temperature and position measurements. March 2019

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): APSC 112

MECH 216 DELETED-Instrumentation and Measurement Labs F | K2

Lecture: Yes
Lab: Yes
Tutorial: No
This course is composed of active lab modules that provide hands-on practical experience to complement the theory presented in MECH 215. On completion of the course, students will be able to: Install and test a micro controller system for data acquisition and control; Acquire and process digital and analog data; Apply transducers for temperature, pressure, stress, strain and force; position, velocity and acceleration; Formulate conclusions supported by data and comparison of results to appropriate models; Discuss the limitations of data employed, key findings, trends evident, uncertainty and error; Create graphs, tables and charts to clearly present data and support conclusions; Compose technical writing to concisely report measurement results and draw valid conclusions. Students will use experimental and numerical skills typically acquired in MTHE 272 and MECH 215. March 2019

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Science 16
Engineering Design 8

PREREQUISITE(S): APSC 112

MECH 217 Measurement in Mechatronics F | K 4.25

Lecture: Yes
Lab: Yes
Tutorial: No
This course is composed of online instruction in measurement theory and active lab and tutorial modules that provide hands-on practical experience making measurements, doing analysis, and drawing conclusions from them. On completion of the course, students will be able to: Identify and Quantify measurement objectives in practical engineering applications; Apply statistical analysis, including uncertainty, for interpreting test results; Specify, Select, and Apply transducers, acquisition systems, and procedures to measure pressure, strain, temperature and position; Apply physical principles to predict static and dynamic system performance for pressure, strain, temperature and position measurements; Install and test a micro controller system for data acquisition and control; Acquire and process digital and analog data; Formulate conclusions supported by data and comparison of results to appropriate models; Discuss the limitations of data employed, key findings, trends evident, uncertainty and error; Students will use mathematical and computational skills typically acquired in MECH 202 & APSC 143. (CEAB App. 3 qualified)

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 15

PREREQUISITE(S): APSC 112

MECH 221 Solid Mechanics I F, O/L | 4

Lecture: 3
Lab: 0
Tutorial: 1
Review of statics, forces and equilibrium, internal forces in simple structures and other material from first year. Further development of axial, torsion, shear and bending moment diagrams, and concepts of stress and strain. Introduction to mechanical properties of materials, centroids and moments of areas, axial stress, flexural stress, transverse shear stress, calculation of displacement by integration, combined loading, and stress transformation. This course is designed

primarily for mechanical engineering students.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 48
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 171, and APSC 182 or permission of instructor
EXCLUSION(S): CIVL 220, CIVL 230

MECH 228 Kinematics and Dynamics W | K3.5

Lecture: No
Lab: Yes
Tutorial: No
This course will cover the following topics in the field of dynamics. Kinematics of particles: planar and three-dimensional motion (rectilinear, curvilinear), choosing a coordinate system, conversions between systems, space curvilinear motion using vector derivatives, free and constrained paths, relative motion between particles. Kinetics of systems of particles: generalized Newton's Second Law, work and energy, impulse and momentum, conservation of energy and momentum, impact. Students will solve dynamics problems analytically and computationally in an active learning environment.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 31
Engineering Design 0

PREREQUISITE(S): APSC 111, APSC 171

MECH 230 Applied Thermodynamics I F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introductory course in thermodynamics. Topics include: properties and behaviour of pure substances, concepts of heat, work and energy, the First and Second Laws of Thermodynamics, and the analysis of a variety of power and refrigeration cycles.

Academic Units:

Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 12
Engineering Design 0

MECH 241 Fluid Mechanics I W/S/OL | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introductory course in fluid mechanics. Topics include properties of fluids, fluids at rest, manometers and other pressure measuring devices, dimensional analysis, the laws of conservation of mass and momentum, Bernoulli's equation for incompressible flow and the energy equation, flow measurements, elementary pipe flow problems including losses, pumps, etc. On completion of the course students will be able to: Explain Bernoulli based energy equations with reference to energy and hydraulic grade lines, static and dynamic pressure; Explain control volume and control mass analysis with reference to Eulerian and Lagrangian frames, applied forces and flows; Solve simple flow systems for velocity distributions using continuity and Navier Stokes equations with appropriate boundary conditions; Solve flow and force problems in an integral framework using Bernoulli, conservation of mass and momentum; Solve piping system performance problems using Bernoulli with friction, minor losses, pump and turbine performance curves; Calculate pressures and forces on submerged surfaces in a static fluid; Solve scaling problems using dimensionless groups.

Academic Units:
Mathematics 0
Natural Sciences 24
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): APSC 111

MECH 270 Materials Science and Engineering F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides the student with a background in the basic structural concepts of materials and the relationships between processing, structure, properties and performance. The topics will range from atomic bonding and arrangements, through micro-and macro-structures and their influence on properties, to the processing techniques required to produce the desired structures. All current types of engineering materials, including metals, ceramics, polymers, composites and

semiconductors are covered.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 31
Engineering Design 0

MECH 271 Deleted - Materials Science and Engineering |

The lecture material is similar to that in MECH 270 but there is no laboratory component. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0

MECH 273 Materials Science and Engineering Lab F/W | 1.0

Lecture: 0
Lab: 1
Tutorial: 0
This course provides a hands-on exploration of some of the concepts introduced in MECH 270. This will include mechanical testing at room and elevated temperature as well as subsequent examination of microstructure. Results obtained will be related to the mechanisms discussed in MECH 270.

Academic Units:
Mathematics 0
Natural Sciences 3
Complementary Studies 0
Engineering Science 9
Engineering Design 0

COREQUISITE(S): MECH 270

MECH 302 Mathematical and Computational Tools for Mechanical Engineers III F | K3.5

Lecture: Yes
Lab: No

Tutorial: Yes
This course will introduce advanced numerical and statistical methods for the solution of engineering problems, to complement those discussed in MECH 202 and 203. The topics of the course will be presented through problems, models and applications relevant to the Mechanical Engineering Program. On completion of the course the students will be able to: perform spectral analysis, use Laplace transforms, perform multi-variate statistical analysis and global optimization, and implement Bayesian inference.

Academic Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): MECH 203

MECH 310 Digital Systems for Mechatronics F | K4.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
Microcontroller based operation of programmable digital sensors, servo motors, stepper motors, and activation of pneumatic and hydraulic drivers. PLC control of sequential logic operations in mechanical systems. Introduction to frequency response of systems with FFT application for machine health monitoring. Industrial communication standards for local and internet-based information transfer; Internet of Things (IOT) concepts. Off grid systems, photovoltaics, and inverters. Lab activities will focus on design, construction, and testing of microcontroller based mechatronic systems for practical applications, building on skills developed in MECH 217 and MECH 210.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 40
Engineering Design 14

PREREQUISITE(S): MECH 210

MECH 321 Solid Mechanics II F | 3.5

Lecture: 3
Lab: 0

Tutorial: 0.5
This course continues the study of solid mechanics. On completion of the course students will be able to: Calculate the total normal and shear stress at a point and sketch the stress distributions on a cross-section of a structural component (such as a crank) experiencing 3D combined (axial, transverse and/or moment causing) loads and non-symmetric loads; Calculate the residual normal or shear stress at a point and sketch the stress distribution on a cross-section of a structural component that is experiencing axial, torsional and/or bending loads followed by unloading; Calculate the normal or shear stress at a point on a cross-section of a structural component that is under load (axial, torsional and/or bending) and is supported in a statically indeterminate configuration (using force balance equations together with compatibility equations derived from known boundary conditions); Calculate the normal or shear stress at a point on a cross-section of a structural component that is under load (axial, torsional and/or bending) and contains one or more locations of stress concentration; Calculate, using general equations and/or graphically using a Mohr's circle, the normal and shear stress and/or strain transformations at a point within a structural component under load as a function of the orientation relative to a fixed coordinate system and find the maximum in-plane normal and shear stress and/or strain; Calculate the deflections and angles of deflection at any point on a transversely loaded beam of uniform cross-section using the principle of superposition and the standard equations for single loads acting on simply supported beams; Solve for critical loads in terms of buckling for concentrically and eccentrically loaded columns; Calculate the optimum dimensions (design) for shafts and beams under combined 3D loading based on specified material failure criteria; Design mechanism or structural components to withstand all forces for given loads, maximum deflection tolerances, factor of safety and material properties.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): MECH 221

MECH 323 Machine Design W | 4.5

Lecture: 3
Lab: 1
Tutorial: 0.5
This course emphasizes the application of theoretical and engineering background taught in other courses, but also relies heavily on empirical approaches and simplifications of theory. Core material includes static and fatigue failure theories and the design/specification of selected machine elements. The course is centered around a major design project which is undertaken in groups.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 27

PREREQUISITE(S): APSC 200 or APSC 202, MECH 321

MECH 328 Dynamics and Vibration F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course covers the kinematics and dynamics of rigid bodies in two and three dimensions, as well as an introduction to vibrations. Topics in dynamics include: mathematically rigorous kinematic analysis, Newton's laws, energy methods, impulse and momentum methods, mass moments of inertia, and gyroscopic motion. Topics in vibrations include: free and forced vibration of single-degree-of-freedom systems, undamped and damped systems, equivalent single degree of freedom system of continuous elements/systems using energy equivalence and equation of motion.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 17
Engineering Design 14

PREREQUISITE(S): MECH 228

MECH 330 Applied Thermodynamics II F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A continuation of MECH 230 with selected topics such as gas and vapour power cycles, refrigeration, mixtures of gases and vapours, combustion and available energy.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42

Engineering Design 0

PREREQUISITE(S): MECH 230 or ENPH 274 (PHYS 274)

MECH 333 Gender, Engineering and Technology W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course examines relations between gender and technology. The main topics covered are: the role of technology on the shaping of society particularly in terms of gendering of jobs and exclusion of women, gender issues in the workplace, the impact of technology on women's lives, and women's impacts on technology. Historical perspectives are presented and contemporary examples from western and developing countries are discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

MECH 341 Fluid Mechanics II W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A second course in fluid mechanics covering the differential form of conservation laws, boundary layer and external flows, compressible flows and the operation of rotational fluid machinery. On completion of the course students will be able to: Apply control volume analysis to mass, momentum and energy conservation; Apply differential form of mass and momentum conservation to the concept of flow field and its properties, including Navier Stokes equations; Apply stream function and velocity potential to the analysis of two-dimensional inviscid flows, and use the superposition principle to build complex flow fields from building block ingredients; Calculate drag and lift on solid bodies such as airfoils; Explain boundary layer flows, including the concept of various boundary layer thicknesses, shape factor, flow separation and the difference between laminar and turbulent boundary layers; Explain compressible flow features based on one-dimensional compressible subsonic and supersonic flows, with and without normal shock waves; Calculate design parameters of rotational fluid machinery, including centrifugal pumps and wind turbines.

Academic Units:
Mathematics 11
Natural Sciences 0

Complementary Studies 0
Engineering Science 31
Engineering Design 0

PREREQUISITE(S): MECH 241

MECH 346 Heat Transfer W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introductory course which covers conduction, convection and radiation modes of heat transfer. Both analytical and numerical analysis will be discussed, and concepts will be reinforced through tutorial and laboratory sessions. Latter topics will include combined modes of heat transfer and the design of heat exchangers.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): MECH 230 or ENPH 274 (PHYS 274) and MECH 241 or MECH 341

MECH 350 Automatic Control W | 3.5

Lecture: 2.75
Lab: 0.25
Tutorial: 0.5
An introduction to the basic principles of modelling, analysis and control of dynamic systems. Topics include: modes of control, principles of feedback, Laplace and transfer functions, transient response of first and second order systems, stability criteria, root locus, Bode and frequency response. After completion of this course a student will be able to design a control system by classical techniques and will have an awareness of modern techniques.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 23
Engineering Design 19

PREREQUISITE(S): MTHE 225 (MATH 225) or MECH 203, and MECH 328 or ENPH 211 (PHYS 211) and ENPH 225 (PHYS 225), or MTHE 235 and MECH 228

MECH 361 NOT OFFERED 2021-2022 - Project Based Engineering: Conceive, Design, Implement and Operate W | K3.5

Lecture: No
Lab: Yes
Tutorial: No
This course provides academic credit for 3rd year students who take a lead role in design and implementation of an engineering device of substantial complexity that is part of a student project. The student has to demonstrate significant involvement with the project during the Fall term and be recommended by an academic advisor in order to qualify and be approved by the course coordinator. Students who are permitted to take this course will be required to "conceive, design, implement and operate" a sub-system or complete competition entry using the knowledge and skills acquired in earlier courses. Successful course completion will consist of specification of function, analysis, selection of materials and/or components, preparation of working drawings, manufactured prototype, completed with a major report and poster presentation. The evaluation will be based on joint assessment by the project academic advisor and the course coordinator.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 42

PREREQUISITE(S): Completion of 2nd Year and permission of the course coordinator upon the recommendation by the academic advisor.

MECH 370 Principles of Materials Processing F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The basic mechanisms of mass transport and phase transformations in materials are developed from thermodynamic and kinetic principles. Topics include phase equilibria, diffusion, solidification and solid-state transformations. The application of these phenomena to materials processing methods, such as casting, forming, heat treatment and sintering is described.

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0

Engineering Science 24
Engineering Design 0

PREREQUISITE(S): MECH 270

MECH 371 Fracture Mechanics and Dislocation Theory W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Fracture Mechanics are developed to explain crack propagation in materials and structures. This includes development of the strain energy release rate (GIC) and the critical stress intensity factor (KIC). Emphasis will be placed on developing the correlation between microstructure control and the resistance to crack propagation which this variable produces. Dislocation theory will be evoked to analyze the stress fields of point, line and plane defects. Plasticity and fracture will be detailed, which includes the time dependent aspects of such processes as static fatigue and creep fracture.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 20
Engineering Design 11

PREREQUISITE(S): MECH 270

MECH 391 Deleted - Technical Communication - Advanced |

This course provides advanced instruction and practice in effective technical writing (individual and team writing) and editing. Some exercises will be linked to required technical communication tasks in other courses. Open to Mechanical and Materials Engineering students only. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 292 or MECH 290

MECH 393 Biomechanical Product Development W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course focuses on design, manufacturing and product management of various implantable biomechanical devices, such as artificial joints, ligaments and various other external devices for persons with disabilities. Some aspects, such as the determination of the geometry and different sizes for artificial joints are product specific, while safety criteria, standards, rational choice of alternatives, design procedures and product management are applicable when designing a much larger variety of products. Much of the theory will be based on examples of artificial joints, and on external devices and instruments.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 24

MECH 394 Frontiers in Biomechanical Engineering F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course addresses the fundamental principles of biomechanical engineering through four introductory modules, each dedicated to one topic: biology, biomechanics, biotransport, and mechatronics. Each module introduces the background and technical principles required to understand topics in biomechanical engineering. This course content emphasizes the multidisciplinary approaches needed to understand a problem from both biology and mechanical engineering perspectives and includes guest lectures given by biomechanical engineering experts with a goal of providing students with exposure to the current biomechanical engineering research landscape.
Students are presumed to have sound background in mechanical measurement, solid mechanics, kinematics and dynamics typically acquired from MECH 217, 221, 228, 321 and 328.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0

PREREQUISITE(S): MECH 217, MECH 221, MECH 228, or permission of instructor
EXCLUSION(S): CHEE 340

MECH 396 Mechanical and Materials Engineering Laboratory I F | K2

Lecture: Yes
Lab: Yes
Tutorial: Yes
This is the first of two laboratory courses in the third year of the Materials Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year or permission of the instructor.
COREQUISITE(S): MECH 370
EXCLUSION(S): MECH 398

MECH 397 Mechanical and Materials Engineering Laboratory II W | K2

Lecture: Yes
Lab: Yes
Tutorial: Yes
This is the second of two laboratory courses in the third year of the Materials Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Approximately half of the material is common with MECH 399.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year or permission of the instructor
COREQUISITE(S): MECH 371
EXCLUSION(S): MECH 399

MECH 398 Mechanical Engineering Laboratory I F | K2

Lecture: Yes
Lab: Yes
Tutorial: Yes
This is the first of two laboratory courses in the third year of the General Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Lab modules from MECH 396/MECH 397/MECH 399 completed but not counted for credit may be included for credit in this course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year or permission of the instructor.
EXCLUSION(S): MECH 396

MECH 399 Mechanical Engineering Laboratory II W | K2

Lecture: Yes
Lab: Yes
Tutorial: Yes
This is the second of two laboratory courses in the third year of the General Option of the Mechanical Engineering program. Lecture topics and course assignments are selected to provide the background required to undertake the laboratory work. Lab modules from MECH 396/MECH 397/MECH 398 completed but not counted for credit may be included for credit in this course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): Completion of 2nd year or permission of the instructor.
EXCLUSION(S): MECH 397

MECH 420 NOT OFFERED 2021-2022 - Vibrations W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Considers mechanical vibration, the problems it presents and the means of dealing with it.

Completes the treatment of systems with two degrees-of-freedom (introduced in MECH 328) and proceeds to systems with higher number of degrees-of-freedom. Co-ordinate systems, types of coupling, matrix formulation, vibration absorbers and dampers, specific and hysteretic damping, Rayleigh's method, torsional vibration, Holzer method, introduction to the finite element method, beam vibration.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 29
Engineering Design 13

PREREQUISITE(S): MECH 328 or ENPH 211 (PHYS 211) and ENPH 225 (PHYS 225)

MECH 423 Introduction to Microsystems W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course will deal with the practical engineering aspects of micro-machining technologies and microsystems. The contents will include: scaling issues, microfabrication technologies and production methods, classification and analysis of Microsystems (including microsensors, microactuators, RF switches, micromirrors, and other micromechanisms), the integration of devices into Microsystems (both assembly and interfacing). Micro-machining will be compared and contrasted to both micro-electronics and traditional macro-machining. The development and use of Microsystems simulation and design tools will be covered as well.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 25
Engineering Design 17

MECH 424 NOT OFFERED 2021-2022 - Sustainable Product Design F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course deals with sustainable product design and manufacture. Topics include: product Life Cycle Analysis issues; Streamlined Life Cycle Analysis and international Life Cycle Analysis standards; Energy, Global Warming Potential, Green House Gas and carbon emission issues (including energy needs in product design and manufacturing); Carbon footprint, basic chemistry

of carbon emissions, international standards for carbon emissions signatures. Design topics include: product design for manufacture and assembly, design for disassembly and design for environment. Product end-of-life considerations include: recycling, remanufacture and reuse. Students will complete several open ended projects. Guest speakers will be included where possible.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 42

PREREQUISITE(S): MECH 323 or permission of the instructor

MECH 430 NOT OFFERED 2021-2022 - Thermal Systems Design W | 4

Lecture: 3
Lab: 0
Tutorial: 1
This course is concerned with the technical, economic and environmental aspects of conventional and novel methods of energy supply and use. Emphasis will be placed on the analysis and design of thermal systems. Topics include: electric utility demand and supply; the analysis of thermal power generation systems including combined cycle and cogeneration plants; emission control; alternative energy systems. A group project related to the design of a thermal system will form a significant portion of this course. NOTE: Limited enrollment.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 24

PREREQUISITE(S): MECH 330, or permission of the instructor

MECH 435 Internal Combustion Engines F | 3.5

Lecture: 3
Lab: 0.08
Tutorial: 0.42
This course covers all aspects of the design and operation of internal combustion engines. Principles of thermodynamics and fluid mechanics are used in the analysis of internal combustion engines. Course content includes discussions on both spark ignition and compression ignition

(diesel) engines with special emphasis placed on new engine technologies. Intake, in-cylinder and exhaust flows are considered along with various aspects of combustion phenomenon relevant to engines. This course includes a laboratory involving engine performance measurements made using a dynamometer.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): MECH 230 or CHEE 210

MECH 437 Fuel Cell Technology F | 3.5

Lecture: 3.0
Lab: 0
Tutorial: 0.5
Introduction to and history of various fuel cell systems. Fuel cell fundamentals including thermodynamics, electrode kinetics, fuel cell performance and transport issues. Systems covered include Polymer Electrolyte Membrane (PEMFC), Direct Methanol (DMFC), Alkaline (AFC), Solid Oxide (SOFC), and Molten Carbonate (MCFC). Fueling processing issues and combined heat and power systems. Overview of the current fuel cell industry.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21

MECH 439 Turbomachinery W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Fluid mechanics and thermodynamics applied to turbomachines; dimensionless performance characteristics; momentum and energy equations; thermodynamics and efficiencies; cascade aerodynamics; compressors and turbines, reaction and stage loading; radial equilibrium; radial flow machines; application of generalized performance to choice of compressors; mechanical details and auxiliary systems.

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): MECH 330, MECH 341, or permission of the instructor

MECH 441 NOT OFFERED 2021-2022 - Fluid Mechanics III W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Topics will include: Derivation of equations of motion for incompressible fluids; exact solutions for laminar flows; stability and transition; introduction to turbulence, including turbulent boundary layers, jets, wakes and mixing layers; drag reduction; introduction to the modelling of turbulence.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

PREREQUISITE(S): MECH 341

MECH 444 NOT OFFERED 2021-2022 - Computational Fluid Dynamics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides an overview of, and hands-on experience in, the numerical modelling of fluid flows. Finite volume, finite difference and finite elements methods are introduced. Students are expected to gain critical insight into the capabilities and limitations of fluid flow models by numerically simulating various engineering flows and by doing a term project. Topics include: comparison of numerical, experimental and analytical methods in fluid mechanics, numerical grids and their generation, flow equations and their discretization, solution techniques, turbulence modelling and data presentation. Features of commercial codes are critically reviewed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0

Engineering Science 30
Engineering Design 12

PREREQUISITE(S): MTHE 272 (MATH 272) or ENPH 213 (PHYS 213), MECH 341

MECH 448 Compressible Fluid Flow W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Introduction and review of work done in earlier courses; basic equations for one-dimensional compressible flow; isentropic one-dimensional flow; steady and unsteady normal shock waves; oblique shock waves; steady and unsteady expansion waves; two-dimensional isentropic flow; nozzle flows; effects of friction and heat transfer; boundary layer flow; design of aircraft engine intake systems; design of supersonic wind-tunnels and shock tubes. Students are expected to have knowledge of fluid mechanics typically acquired in MECH 241/MECH 341. Those who have not taken these or similar courses will need to prepare through self study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 31
Engineering Design 11

MECH 452 Mechatronics Engineering F | 5

Lecture: 2
Lab: 2.5
Tutorial: 0.5
This is a course in mechatronic systems design. Mechatronics Engineering, an integration of computer, electrical and mechanical engineering, is studied in a series of workshops that focus on electronics, microcontrollers, programmable logic controllers and mobile robots. The lectures provide the theoretical background to the workshops, and include discussion of related industrial and commercial applications. The knowledge and experience gained in the lectures and workshops is applied to a team design project. Students will use their knowledge of electric circuits, microcontrollers and control systems typically acquired in MECH 210, MECH 217 and MECH 350.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30

Engineering Design 30

PREREQUISITE(S): Permission of the instructor

MECH 455 Computer Integrated Manufacturing F | 3.5

Lecture: 2
Lab: 1.5
Tutorial: 0
The course will focus on the integration of facilities (machine tools, robotics) and the automation protocols required in the implementation of computer integrated manufacturing. Specific concepts addressed include flexible manufacturing systems (FMS); interfaces between computer aided design and computer aided manufacturing systems; islands of automation.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21

MECH 456 Introduction to Robotics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course will cover the following topics in the field of robotics: historical development; robot components (sensors, actuators, and end effectors, and their selection criteria); basic categories of robots (serial and parallel manipulators, mobile robots); mobility/constraint analysis; workspace analysis; rigid body kinematics (homogeneous transformation, angle and axis of rotation, Euler angles); manipulator kinematics and motion trajectories (displacement and velocity analyses, differential relations, Jacobian matrix); non-redundant and redundant sensing/actuation of manipulators; manipulator statics (force and stiffness); singularities; and manipulator dynamics.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 21

PREREQUISITE(S): MECH 350 or MTHE 332 (MATH 332) or ELEC 443 or permission of the instructor
EXCLUSION(S): ELEC 448

MECH 457 Additive Manufacturing W | 4

Lecture: 3
Lab: 1
Tutorial: 0
This elective course provides a comprehensive introduction to additive manufacturing (AM), with an emphasis on a scientific/technical approach to process/product design, as well as troubleshooting, for various industrial applications. The course includes an overview of AM techniques (including process configurations, processing conditions and the common machinery/instruments), followed by part design, process design & optimization in the context of AM and AM process modelling and control. Both polymer 3D printing and metal powder-based techniques will be covered. The theoretical course material will be complemented by a group-based practical/hands-on project using the existing AM facility within the department.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 48
Engineering Design 0

PREREQUISITE(S): MECH 213 or (MECH 211 and MECH 212), MECH 270, MECH 203

MECH 458 DELETED - Machine Condition Monitoring and Fault Diagnostics F | 3.5

Lecture: 3
Lab: 0.17
Tutorial: 0.33
The primary objective of this course is to introduce students to the dynamic behaviour of rotating machinery (but other machinery classes will also be included) and to discuss appropriate fault and mechanical deterioration detection and diagnostic criteria and schemes for various applications. Emphasis will be placed on the application of vibration based methods of data acquisition and analysis techniques. There will be a laboratory component that will provide the students with demonstrations and the opportunity to collect and analyze vibration data from a set of mechanical fault simulators. Topics will include, but not be limited to; basic maintenance philosophies and strategies, vibration signal measurement and recording instrumentation, dynamic signal analysis and display, vibration level standards, rotating machinery balancing, shaft alignment, rolling element and journal bearing faults, gear wear detection and case studies. Correlation of infra-red thermography, oil analysis and other methods of fault detection and diagnostic techniques with vibration based methods will also be discussed. Deleted 2016-2017

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Science 28
Engineering Design 14

PREREQUISITE(S): MECH 328 or ENPH 321 (PHYS 321)

MECH 460 Team Project - Conceive and Design F | K4

Lecture: Yes
Lab: Yes
Tutorial: Yes
Students working in teams will be required to "conceive and design" a product, system or process using the knowledge and skills acquired in earlier courses. Elements of the design will include: specification of function, analysis, selection of materials and/or components, preparation of working drawings, cost analysis and tenders, and preparation of preliminary design report. A research project may be accepted as an engineering design project provided it can be clearly shown that the elements of "conceive and design" are fulfilled in the completion of the project. Lectures and Guest Speakers will focus on related professional skills and topics including engineering ethics, professional organizations and legislation, intellectual property and information systems in support of the project.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 48

PREREQUISITE(S): MECH 321, MECH 323, MECH 328, MECH 346 and MECH 350, or in final year of MECH program.
COREQUISITE(S): MECH 464

MECH 461 Research Project W | K4

Lecture: No
Lab: Yes
Tutorial: No
This course provides an opportunity for students to work individually on an engineering research project with staff members of the Department. The topic is selected by the student in consultation with a Department supervising faculty member by the end of the Fall term. The projects are laboratory-based to be completed by the end of the Winter term with a major report and presentation of the work.

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 48
Engineering Design 0

PREREQUISITE(S): Completion of 3rd year and permission of the instructor.

MECH 462 Team Project - Implement and Operate W | K3.5

Lecture: Yes
Lab: Yes
Tutorial: Yes
This course is intended to enable team projects that started in MECH 460, to continue to the "implement and operate" phases of the design cycle. However, new projects can be the subject of MECH 462 as long as they meet the "implement and operate" objectives of the course. An engineering report is prepared and defended. The presentation is normally supported by a working prototype or physical mock-up of the design. Testing a process or system can replace the building of a prototype. Choices of available projects are limited and should be discussed with the instructor.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 42

PREREQUISITE(S): MECH 460

MECH 463 Engineering Project for International Students F/W | K 2

Lecture: No
Lab: Yes
Tutorial: No
This course is for students registered at a university outside Canada who wish to do a research project at Queen's to satisfy the requirements of their home university. Projects must be initiated by a faculty supervisor at the student's home university in consultation with a Queen's professor who has agreed to act as a supervisor. The time frame and requirements for course completion will be agreed upon by the two project supervisors prior to the student arriving at Queen's. This course is NOT available or intended for typical exchange agreement students.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 24

PREREQUISITE(S): Permission of instructor.

MECH 464 Communications and Project Management F | 1.5

Lecture: 0.75
Lab: 0
Tutorial: 0.75
This course provides advanced instruction and practice in technical communication and project management for multidisciplinary engineering projects. Content includes request for proposals, project planning and proposal writing, quality function deployment, oral presentation skills, client communications and concise report writing. Course deliverables are closely tied to deliverables in Capstone design courses. Open to Mechanical and Materials Engineering students only.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 0
Engineering Design 0

COREQUISITE(S): MECH 460 or permission of the instructor

MECH 465 Computer-Aided Design F | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Concept of computational design including the choice of the objective function, equality and inequality constraints, and analysis methods; one-dimensional search methods, sensitivity analysis, and the steepest descent method. The principles of the finite element method and its application to stress analysis of mechanical components. The prerequisite may be waived for students with a strong background in solid mechanics from other courses. NOTE: Enrolment is limited.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 11

Engineering Design 31

PREREQUISITE(S): MECH 323 and Permission of the instructor

MECH 470 Deformation Processing W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course focuses on the elastic-plastic deformation of metals as it relates to the fabrication of stock materials, the manufacture of components and in-service material performance. Methods for describing and analyzing elastic-plastic behaviour, at both macroscopic and microscopic length-scales, are presented. Additional topics include the measurement and prediction of forming limits, the effects of deformation rate and temperature on plastic flow, and mechanisms of ductile failure. In the final portion of the course, the concept of microstructural design is introduced and then reinforced through a series of case studies.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): MECH 371

MECH 474 Deleted - Functional Ceramics |

This course is designed to provide an understanding of the relationship between composition, defect structure and electrical and thermal properties of functional ceramics. Emphasis is placed on the mechanisms of conduction in insulators, semiconductor ceramics and fast ionic conductors. The origin of ferroelectricity and piezoelectricity is presented for isotropic and anisotropic materials using tensors and matrix notations. Several ceramic systems and related devices are presented, including electronic and ionic conductors, ferroelectrics and dielectric materials. The design and operation of modern electrical/electronic devices, such as solid oxide fuel cells, varistors and smart structures, are discussed in detail. The breadth and importance of this class of ceramics in modern electronic industries are reviewed. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30

Engineering Design 12

PREREQUISITE(S): MECH 370

MECH 475 Deleted - Structural Ceramics |

The course deals with processing, structure and properties of advanced ceramics possessing a combination of properties not found in other classes of materials. Emphasis is placed on understanding the brittle nature of ceramics through the concept of linear-elastic fracture mechanics. The relationship between microstructure (eg. grain size, porosity and phase content) and mechanical properties (eg. strength, toughness and hardness) is developed using crack opening displacement analysis. The role of anisotropy and residual stresses in the development of high strength ceramics and structures is also discussed. Different mechanisms for the sintering of advanced structural ceramics are also covered along with forming and densification of high performance carbides, nitrides and oxides. - COURSE DELETED 2012-2013

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 28
Engineering Design 14

PREREQUISITE(S): MECH 371

MECH 476 Engineering of Polymers and Composite Materials W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course introduces the microstructure-property-processing relationships needed to understand the applicability of polymers and composites to engineering design. The courses start with an introduction to the structure and properties of different polymers. The mechanics of polymers are covered including elasticity, rubber elasticity, pressure dependent yield and viscoelasticity. The mechanics of composites depend not only on the matrix, but also on the reinforcing phase. While focussing on polymer composites, metal and ceramic-based composites will also be introduced. Topics covered will include the influence of the interface, mechanical and transport properties and design of composites. The final goal is to correlate constitutive relations describing the time-temperature dependence of mechanical properties of polymers and composites to microstructure and linking these relations to practical design.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Science 24
Engineering Design 18

PREREQUISITE(S): MECH 370, MECH 371

MECH 478 Biomaterials F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the structure, properties and performance of biomaterials used for the construction of medical devices. Examples of biomaterials are bioactive ceramics, biodegradable polymers and advanced titanium-based alloys used for the construction of orthopedic implants. Topics covered will include surface and bulk properties of biomaterials and their impact on the clinical performance of implants. Discussion will focus on tissue-biomaterials interactions, biocompatibility and biodegradation. The course will also cover the current in-vitro and in-vivo testing methods for evaluating the long-term performance of biomaterials.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 31

MECH 479 Nano-Structured Materials F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The majority of conventional materials have grain or crystallite sizes ranging from micrometers to several millimeters. Capabilities now exist to synthesize materials with grains where one or more dimension is on the nanoscale (less than 100 nm). As the grain size decreases, there is a significant increase in the volume fraction of grain boundaries or interfaces. This characteristic strongly influences the chemical and physical properties of the materials. For example, nanostructured ceramics are tougher and stronger than coarser grained ceramics, while nanostructured metals exhibit increases in yield strength and elastic modulus. It has also been shown that other properties (e.g. electrical, optical and magnetic) are influenced by a fine grain structure. The goal of this course is to introduce the student to the impact of length scale, from millimeter to nanometer, on material properties, with a primary but not exclusive focus on mechanical properties. It will include discussions on synethesis approaches as well as examples of applications.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 20
Engineering Design 11

PREREQUISITE(S): MECH 370, MECH 371

MECH 480 Airplane Aerodynamics and Performance W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A technical course on the principles of flight. Techniques for the quantitative prediction of the aerodynamic characteristics of the wing will be described. Extensions to account for real-world effects will be discussed. These results will be used to predict the airplane performance (range, climb rate, maximum speed, etc.) The concept aerodynamic stability will be introduced and discussed. Students are expected to know MATLAB proficiently and have fluids knowledge typically acquired in MECH 241 and MECH 341. Those who have not taken these or similar courses will need to prepare through self study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

MECH 481 NOT OFFERED 2021-2022 - Wind Energy F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introductory course on wind-turbine operation and aerodynamics. Topics include: the Betz limit; the Blade Element Momentum method; characteristics of the atmospheric boundary layer; unsteady aerodynamic theory; gusts and blade aeroelasticity; blade noise and health effects; and wind-park siting and planning. Extension of some of these topics to small wind turbines, run-of-the-river water turbines and off-grid systems will also be presented. Students are expected to have sufficient experience with fluid dynamics equivalent to MECH 341. Those who have not taken such a course will need to prepare through self-study.

Academic Units:
Mathematics 0

Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

MECH 482 Noise Control W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the principles of noise control. Topics include: basic properties of sound and noise, the measurement of noise, effects of noise on people, description of sound fields, acoustics of rooms and enclosures, acoustical materials and structures, and noise source identification. A coherent approach to the solution of noise control problems is stressed throughout the course.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 25
Engineering Design 17

MECH 483 Nuclear Materials F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
A nuclear reactor presents a unique environment in which materials must perform. In addition to the high temperatures and stresses to which materials are subjected in conventional applications, nuclear materials are subjected to various kinds of radiation which affect their performance, and often this dictates a requirement for a unique property (for example, a low cross section for thermal neutron absorption) that is not relevant in conventional applications. The effects of the radiation may be direct (e.g., the displacement of atoms form their normal positions by fast neutrons or fission fragments), or indirect (e.g., a more aggressive chemical environment caused by radiolytic decomposition). This course describes materials and structures typically used in nuclear environments, their manufacture, the unique conditions to which they are subjected, the basic physical phenomena that affect their performance and the resulting design and operational requirements for reactor components. The course includes a field trips to components manufacturers and to Canada's national nuclear research laboratory.

Academic Units:
Mathematics 0
Natural Sciences 11
Complementary Studies 0

Engineering Science 20
Engineering Design 11

PREREQUISITE(S): MECH 370, MECH 371

MECH 484 DELETED - Introduction to Ceramics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introduction to the processing, structure and properties of advanced ceramics used for the design of components in electronic, automotive, aerospace, energy, mining and chemical and petrochemical industries. The emphasis is placed on understanding the relationship between microstructure and mechanical, electrical and thermal properties of ceramics. Ceramic systems and related devices which are discussed include electronic and ionic conductors, capacitors, transducers, varistors, and dielectric substartes. The effect of porosity, grain size and residual stresses on strength, elastic and fracture properties of isotropic and anisotropic ceramics is also discussed. Material transport mechanism and sintering of powder ceramics materials is covered with recent examples of forming and sintering of oxides, carbides and nitrides. Jan. 2020

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 30
Engineering Design 12

PREREQUISITE(S): MECH 370 and MECH 371

MECH 492 Biological Fluid Dynamics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
An introductory course on biological flows across a broad range of scales from flagellar motility to the beating heart. Topics range from the dynamics of classical biomedical flows such as the circulatory and respiratory systems. (e.g. wall compliance, pulsatility, and transition to turbulence) through to cellular-level motility and biopropulsion in general over a range of Reynolds numbers. Topics relating to comparative biology (e.g. allometry and evolutionary convergence) and common imaging techniques used for biological flows (e.g. acoustic, nuclear magnetic resonance, optical and x-ray techniques) will be covered as well.
Students are expected to have sufficient experience with measurement science and fluid dynamics theory equivalent to MECH 217 and MECH 241. Those who have not taken such courses will need to prepare through self-study.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 42
Engineering Design 0

MECH 494 Kinematics of Human Motion W | 3.5

Lecture: 2
Lab: 1
Tutorial: 0.5
In this course students will explore the application of classical mechanics to the analysis of human motion related to athletics, orthopaedics, and rehabilitation. The course covers the structure of human joints, including experimental and analytical techniques in the study of human joint kinematics; applications to the design of artificial joints and to clinical diagnosis and treatments. Students are introduced to the motion capabilities of the human body and how to develop and study kinematic models of the individual joints of the human body. Experimental methods used to collect kinematic data will be studied through interactive labs. Topics include defining body position and displacement, three dimensional representation of human motion, basic functional anatomy of individual joints, rigid body kinematics (homogeneous transformations, Euler angles, helical axis), intrajoint kinematics, joint modelling, articular surface motion. Three-dimensional kinematics of individual joints is emphasized from the perspective of total joint replacement design.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 30

PREREQUISITE(S): MECH 393 and MECH 394, or permission of instructor

MECH 495 NOT OFFERED 2021-2022 - Ergonomics and Design W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
This course provides an overview of ergonomic problems that are addressed in engineering design; including biomechanical, physical and physiological issues. Case studies will range from the design of vehicle cockpits to process control rooms, from industrial manual materials handling tasks to human directed robots, and from domestic tools to biomechanical devices.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 42

PREREQUISITE(S): MECH 323 or permission of the instructor

MECH 496 Musculoskeletal Biomechanics F | 3.5

Lecture: 2
Lab: 1
Tutorial: 0.5
Develops approaches to musculoskeletal biomechanics, including experimental and analytical approaches to movement analysis, experimental instrumentation and devices, and biomechanical devices for musculoskeletal disorder rehabilitations. Analysis of the contribution of external loading, forces generated by muscles and constraints provided by other musculoskeletal structures to predict forces and stresses in musculoskeletal joints and tissues. Numerical and modelling approaches, including inverse dynamics, and optimization, and determination of segmental inertial properties. Biomechanical devices including upper limb and lower limb orthotics and prosthetics. Applications in orthopaedic engineering, movement assessment, ergonomics, joint injury and replacements, and biomechanical system design. Application of machine learning in biomechanics and human movement analysis.
Students are presumed to have had a sound introduction to biomechanics, typically acquired from MECH 394.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 20
Engineering Design 22

PREREQUISITE(S): MECH 328

Mining Engineering

MINE 201 Introduction to Mining and Mineral Processing F | 4

Lecture: 3
Lab: 0
Tutorial: 1

This course presents and overview of all aspects of mining from exploration, financing, development and mining operations. Underground and open pit mining are contrasted. Mineral processing systems for the production of gold, diamonds, copper, nickel, zinc and iron will be studied. Topics include decision-making process related to world market commodity pricing, mine planning and design, mining equipment, blasting and environmental considerations. Concepts of sustainability from economic, social and environmental perspective will be explored. Case studies, a major field trip and related assessment will be used to illustrate principles taught and how they are applied in a practical situation. Conservation equations for mass and energy, process flow diagrams, material and energy balances, First Law of Thermodynamics.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 36
Engineering Design 0

PREREQUISITE(S): must be enrolled in Mining Engineering, or permission of instructor

MINE 202 DELETED - Computer Applications and Instrumentation in Mining F | 1.5

Lecture: 0
Lab: 1.5
Tutorial: 0
The objective of this course is to offer students a hands-on introduction to some of the fundamental tools and techniques of contemporary instrumentation and data analysis, with application examples from both surface and underground mining. Topics covered include an introduction to engineering measurements and the statistical nature of measured data, fundamentals of signal analysis and computer-based data acquisitions systems, introduction to common sensors and their applications, and the use of standard engineering software for data processing and analysis. Course material is delivered via a sequence of workshop-style sessions. Jan. 2020

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 6

COREQUISITE(S): MINE 201

MINE 225 Applied Rock Mechanics (only offered in 2018-2019 & 2019-2020, same course as MINE 325) W | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
This course deals with the principles of solid mechanics as applied to geologic materials in order to examine the effects of stress, strain and other factors on the geomechanical responses of such materials to these influences. Topics covered include rheological behaviour of rocks, stress measurement and prediction, and measurement procedures for determination of rock strength and other characteristic parameters. Failure theories are discussed and used to describe fracture development and design considerations for underground and surface mine structures. Analytical techniques based on empirical knowledge and supported by available theory and engineering practice are presented, including, for example: slope stability, underground structure and rock foundation design; the influences of ground water, rockbursts and backfill support on structural stability of excavations; and discussion of potential hazards associated with each. The operation and design of instrumentation used for rock mechanics studies are also discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 54
Engineering Design 0

PREREQUISITE(S): CIVL 230 and MINE 202 or permission of the instructor

MINE 244 Underground Mining (changed to MINE 344) W | 3

Academic Units:

MINE 262 Deleted - Engineering Surveying S | 3.5

Lecture: 1.5
Lab: 0
Tutorial: 2
This introductory course in plane surveying consists of about 16 hours of lectures, the rest of the time being spent in the field. Lecture material includes distance measurement, differential, profile and indirect leveling and use of transit, traversing and mapping. Errors, corrections and balancing are also discussed. The use of available software packages for the reduction and calculation of data is encouraged throughout the course. In the field, students practice the basic techniques of instrument use through various assignments. Careful and efficient handling of instruments and proper note-keeping are stressed. The use of state-of-the-art electronic surveying instruments is included in the field assignments wherever possible. The school is held on campus immediately following the final First Year examination in April. - COURSE DELETED 2013-2014

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 40
Engineering Design 0

PREREQUISITE(S): Must be enrolled in Mining Engineering
EXCLUSION(S): CIVL 211

MINE 267 Applied Chemistry for Mining W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides an overview of the chemistry of inorganic and organic compounds used in the practice of mining and mineral processing including hydro-and pyro-extractive methods. Chemistry and chemical interactions for selected reagent formulations used in blasting, flotation/flocculation, leaching/precipitation, solvent extraction/electrowinning and pollution control technologies are outlined with relevant stoichiometry. Mineral stability and its relevance to metal extraction is discussed. Unary, binary and ternary phase diagrams are explored. The properties of solutions of interest are reviewed.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132

COREQUISITE(S): MINE 268 or permission of the instructor

MINE 268 Analytical Methods in Mining W | 1

Lecture: 0
Lab: 1
Tutorial: 0
This course exposes the students to the analytical techniques utilized in the mining and the mineral processing industries. The first part of each laboratory includes the principles of the analytical technique while the second part is concerned with the practical use of the technique. The analytical techniques are typical of those of analytical groups in most mining companies. The techniques studied include: sampling, digestion, Atomic Absorption Spectroscopy, Induction Coupled Plasma Spectroscopy, X-Ray Diffraction and fire assay. Safety in handling of hazardous

chemicals is emphasized with a review of selected Material Safety Data Sheets and industry standards.

Academic Units:
Mathematics 0
Natural Sciences 3
Complementary Studies 0
Engineering Science 9
Engineering Design 0

PREREQUISITE(S): APSC 131, APSC 132
COREQUISITE(S): MINE 267

MINE 272 Applied Data Science W | 4.5

Lecture: 3
Lab: 3
Tutorial: 0
This course presents a comprehensive overview of the key elements of data science for engineers. Topics include data cleaning, organization and manipulation, data collection, visualization and noise filtering. Data analysis techniques including regression, decision trees, feature selection, clustering and classification are covered. Emphasis is on spatial analysis and visualization, as well as the analysis of time series. An introduction to advanced topics such as deep learning, big data management and analysis is provided. The focus is on the practical application of data science in the engineering context to make predictions and decisions based on the statistical inference of data.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 54
Engineering Design 0

PREREQUISITE(S): APSC 143 or CISC 101, and CHEE 209 or MTHE 367, or permission of the department
EXCLUSION(S): CISC 251, CMPE 251

MINE 307 NOT OFFERED 2020-2021 Front Line Supervision W | 1.5

Lecture: 1.25
Lab: 0
Tutorial: 0.25
This short course provides a base for engineering graduates placed into leadership positions in

mining organizations. The Supervisor role is defined, core duties of the position are examined and students are given a variety of tools or strategies to achieve the defined goals of the role. Students are exposed to basic principles of leadership particularly coaching techniques and motivation. Safety leadership is highlighted and reinforced extensively throughout the material, most importantly the Supervisor's direct responsibility for ensuring compliance with Safe Operating Procedure and associated Safety norms. The Supervisor's influence in meaningfully contributing to an organization's safety and performance culture is examined and discussed. Important aspects of Performance Management for both individuals and groups are covered with examples from real-life situations. Several cases involving direct and indirect costs associated with situations directly controlled by the Supervisor are studied to reinforce the key link nature of the position. Course material also deals with the subject of change in the workplace and includes strategies for managing it; how a Supervisor can best facilitate change that results in a positive outcome. Detailed discussions are held on common problems facing Supervisors and a simple problem solving methodology is provided along with examples. Course facilitators are experienced mining professionals with a history that includes front-line supervision up to executive positions; all material is reinforced with real-life examples. Students are graded on a pass/fail system. Offered as an intensive 2-day short course in the winter term.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): Must have completed the 2nd year of Mining Engineering

MINE 321 Drilling and Blasting F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
This course deals with the principles of commercial explosives technology and the application of blasting in mining and construction. The planning, design, economic considerations and trends of drilling and blasting practices in the different segments of the mining and construction industries are considered. Topics covered are detonation theory, performance and sensitivity of explosives, fragmentation prediction measurement and control, vibrations from blasting, air blast, damage and special blasting techniques used in perimeter blasting and blast design methods.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Science 25

Engineering Design 15

PREREQUISITE(S): MTHE 367 or CHEE 209

MINE 324 Hydraulics for Mining Applications W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The fluid mechanics basic to fluid hydraulic systems used in the mineral industry are introduced. Topics covered include properties of fluids, fluid statics and its application to mining. Hydrodynamic studies include the energy balance and Bernoulli's equation, energy losses in incompressible flow, the momentum equation and its application, and flow and pressure measuring devices. Flow in closed conduits, including series and parallel pipeline systems and pipe networks, is studied in detail and open channel flow is introduced. Applications include industrial pumps, sump design, hydraulic structures, underground mine dewatering systems, open pit mine drainage systems, and mine backfill and mine tailings transportation.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 30
Engineering Design 0

PREREQUISITE(S): MTHE 225 and MECH 230 or CHEE 210 or permission of the instructor

MINE 325 Applied Rock Mechanics F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
This course deals with the principles of solid mechanics as applied to geologic materials in order to examine the effects of stress, strain and other factors on the geomechanical responses of such materials to these influences. Topics covered include rheological behaviour of rocks, stress measurement and prediction, and measurement procedures for determination of rock strength and other characteristic parameters. Failure theories are discussed and used to describe fracture development and design considerations for underground and surface mine structures. Analytical techniques based on empirical knowledge and supported by available theory and engineering practice are presented, including, for example: slope stability, underground structure and rock foundation design; the influences of ground water, rockbursts and backfill support on structural stability of excavations; and discussion of potential hazards associated with each. The operation and design of instrumentation used for rock mechanics studies are also discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 18

PREREQUISITE(S): CIVL 230 and MINE 202 or permission of the instructor

MINE 326 Operations Research F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
The course deals with the application of operations research methods in engineering with emphasis on mining applications. Topics covered are linear programming, optimization methods, transportation and network models, discrete optimization, non linear optimization, decision tree methods, simulation and elements of geostatistics as applied to mining. Lab sessions also deal with forecasting techniques, regression analysis, dispatch problems, planning and scheduling.

Academic Units:
Mathematics 20
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 20

PREREQUISITE(S): APSC 143 or MNTC 313 or permission of the instructor

MINE 330 Mineral Industry Economics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course for students in Mining Engineering and allied disciplines will apply basic principles of economic evaluation learned in APSC 221 to the minerals industry. Topics covered include: the project definition and economic evaluation process; economic analysis tools and techniques; taxation; inflation; cost estimation; the nature of mineral supply and demand; mineral commodity markets and pricing; uncertainty and risks associated with the mining industry, their analysis and incorporation into the evaluation process. Assignments, examples, and tutorials reflect a variety of situations and challenges faced in the evaluation of exploration and mine development opportunities, as well as important applications to mining and mineral processing design and decision-making.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 42
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 221, must be enrolled in Mining Engineering or they must have or the permission of the instructor (or department)

MINE 331 Methods of Mineral Separation F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Mineral separation processes of a physical and physicochemical nature are studied with laboratory sessions. Topics include size reduction, classification, flotation, flocculation, gravity concentration, magnetic, electrostatic separations and dewatering. Surface phenomena involving fine particle processing, reagent classifications, flotation machines and circuits, plant practice in ore flotation are discussed. The laboratory practice includes a design project on flotation circuit analysis and sizing. Assignments will be completed based on field trip observations.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Science 25
Engineering Design 15

PREREQUISITE(S): MINE 201 and MINE 267 or permission of the instructor

MINE 335 Mineral Processing F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Mineral separation processes of a physical and physicochemical nature are studied. Topics include size reduction, classification, flotation, flocculation, gravity concentration, magnetic, electrostatic separations and dewatering. Surface phenomena involving fine particle processing, reagent classifications, flotation machines and circuits, plant practice in ore flotation are discussed. Quantitative understanding of various topics is aided through problem solving in class and assignments on mass balancing, kinetic analysis and circuit sizing.

Academic Units:

Mathematics 0
Natural Sciences 11
Complementary Studies 0
Engineering Science 16
Engineering Design 9

PREREQUISITE(S): PREREQUISITE(S): MINE 201 or GEOE 281 and MINE 267 or GEOE 365 or CHEE 221 or permission of the instructor

MINE 339 Mine Ventilation F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Hydraulics of air flow through mine openings and ducts is first studied, leading to mine ventilation Hydraulics of air flow through mine openings and ducts is studied, leading to mine ventilation design calculations and ventilation network analysis. Topics related to the design of mine ventilation systems include: statutory regulations and engineering design criteria, ventilation circuit design, natural ventilation, testing, application and selection of mine ventilation fans, auxiliary ventilation design, psychrometry, mine air heating and cooling, dust and fume control, and ventilation economics. Health hazards of mine gases, dust and radiation are reviewed, together with statutory requirements for air quality. Procedures for conducting air quantity and quality surveys are also taught.

Academic Units:
Mathematics 0
Natural Sciences 14
Complementary Studies 0
Engineering Science 15
Engineering Design 25

MINE 341 Open Pit Mining W | 4.5

Lecture: 3
Lab: 0
Tutorial: 1.5
This course presents technologies and techniques employed in open pit mining with a focus on strategic and operations planning considerations. Topics of study include: pit design, application of algorithms for economic pit limit analysis, equipment selection, production scheduling, material control and reconciliation, remote sensing and geomatics applications, mine waste management, emerging trends in open pit mining, and mine safety. Regulatory controls and best practices in design are stressed for all stages of the mine life cycle. Environmental impacts of design decisions and mitigating strategies are explored. The use of software at various stages of

the design and planning process is introduced and a strategic design project completed using commercial software applications.

Academic Units:
Mathematics 14
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 26

PREREQUISITE(S): APSC 221 and MINE 201, or permission of instructor

MINE 344 Underground Mining W | 4

Lecture: 3
Lab: 0
Tutorial: 1
A study of underground mining technology with special reference to economic optimization in both design and production. Conventional and up to date mining methods are reviewed. Developments and trends in mining methods are closely analyzed. Mine design is studied in relation to ore reserves, tonnage and grade distribution, equipment with emphasis on the growing importance of maintenance on underground machinery and capacities of various production units. Development and production costs associated with mining are an inherent aspect of this course. The problems and possibilities of existing and evolving mining techniques are reviewed.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): MINE 201

MINE 422 Mining and Sustainability F | 4

Lecture: 4
Lab: 0
Tutorial: 0
This course describes the evolution of policies, operational procedures and management systems related to sustainability and the social, economic, environmental, ethical, and technical design challenges facing the mining industry. Themes examined will include: international and national performance expectations, standards and regulations; operational and management responses – social and environmental impact risk assessment; stakeholder engagement; impact mitigation

planning and risk management systems; performance monitoring, evaluation and reporting; agreement making and benefit sharing. Students will be introduced to a range of complex situations with significant sustainability implications that need to be addressed responsibly during the life cycle of a mine, such as land acquisition, population and livelihood displacement, cultural heritage and habitat preservation, water use, waste disposal, mining-community relationships, mine closure and its community and environmental implications.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 48
Engineering Science 0
Engineering Design 0

MINE 431 Life-Cycle Assessment for Green Technologies F | 3.5

Lecture: 3
Lab: 0
Tutorial: 1
Life-cycle assessment (LCA) is an ISO standardised framework (ISO 14040/41) for comprehensively examining and assessing the environmental impacts associated with industrial products and systems. It has been widely used by businesses and governments to support decision making for product development, ecolabelling, public policy and planning, and new technology assessment. This course introduces the concepts of LCA, and critically reviews empirical LCA studies at both the product and systems levels. Case-study based activities are used to explore the appropriate use and limitations of LCA as a tool for sustainability assessment, including the use of relevant databases and software. Topics include: Systems approaches to environmental design, assessment, and management; Greenhouse gas (GHG) accounting and carbon footprint; Life-cycle thinking and the ISO assessment framework; methods of life-cycle inventory analysis; methods of life-cycle impact assessment; interpretation of LCA results; uncertainty and sensitivity analysis in LCA; LCA applications in assessing low-carbon technologies and products; life-cycle cost analysis; social life-cycle assessment, life-cycle management and its contribution to SDGs.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 21
Engineering Science 21
Engineering Design 0

PREREQUISITE(S): APSC 132 or CHEM 112, and APSC 174 or MATH 121; open to third- or fourth-year students or permission of the department
EXCLUSION(S): MECH 424

MINE 434 Project Report F/W | 4

Lecture: 1
Lab: 0
Tutorial: 3
In this course, the student is exposed to research in the mining, mineral processing and metal extraction industries. The work is performed under the supervision of a Faculty member. Standing is based on the work done, the ability of individuals to meet project deliverables according to the schedule provided, and individual written and oral presentations made. The deliverables include a research proposal, a research plan and literature review, an oral seminar presentation and a final report in the form of a technical paper. The deliverables can be based on research performed during the fall and winter terms, as an extension of a summer employment research project, or literature-derived research information. Emphasis is placed on the critical treatment of the data obtained to produce useful conclusions.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 24
Engineering Science 0
Engineering Design 24

PREREQUISITE(S):

> Prerequisite : Completion of all 2nd and 3rd year courses in Mining Engineering and permission of the Department

MINE 445 Open Pit Mine Design W | 5.5

Lecture: 1
Lab: 3
Tutorial: 1.5
The material of MINE 341 is applied to the design of an open pit mine. Special attention is given to the selection of equipment and the use of computers in strategic and detailed mine planning and scheduling. The course uses commercial mine planning software to enable small groups of students (2-4) to complete mine designs starting with topography maps, drill information, and mineral inventory block models. Several real deposit databases are used including gold, copper, copper/molybdenum, copper/zinc. The deposits are evaluated, feasibility assessed, and production decisions discussed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 20
Engineering Science 0

Engineering Design 46

PREREQUISITE(S): MINE 330 and MINE 341, and either MINE 326 or MINE 467, or permission of the instructor

MINE 448 Underground Design W | 5.5

Lecture: 1
Lab: 1.5
Tutorial: 3
This course provides an opportunity to apply a knowledge of basics to the design of an underground mine. Initial design information may range from diamond-drill assay data to a partially or completely designed mine. The problem of design or renovation entails ground stability, ventilation, systems analysis, equipment selection, maintenance, etc, with safety and economics as the basic criteria for design.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 0
Engineering Design 48

PREREQUISITE(S): APSC 221, MINE 344, MINE 339, MINE 225 or MINE 325, MINE 467 AND MINE 469 or permission of the instructor

MINE 451 Chemical Extraction of Metals F | 4

Lecture: 3
Lab: 0
Tutorial: 1
The recovery and recycling of metals by both hydrometallurgical and pyrometallurgical techniques is discussed. The thermodynamic and kinetic aspects of the solutions utilized in these processes are reviewed. The major unit operations of the hydrometallurgical and pyrometallurgical processes are studied. For hydrometallurgy, the unit operations are; ion exchange, solvent extraction, cementation, purification, precipitation, electrowinning and electrorefining. Particular emphasis will be placed on the recovery of gold. For pyrometallurgy the unit operations are; roasting, agglomeration, calcination, smelting, converting, refining and electrolysis. In the course, the importance of environmental stewardship in metal extraction is stressed.

Academic Units:
Mathematics 0
Natural Sciences 12

Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): MINE 331 or permission of the instructor

MINE 455 Design, Analysis and Operation of Mineral Processes F | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
Engineering elements of a mineral processing project are examined from the concept stage to process design. Flowsheet evaluation, process equipment selection and layout, capital and operating costs, operating and control strategies are considered for real problems.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 54

PREREQUISITE(S): MINE 331 , or permission of the instructor

MINE 458 Process Investigations W | 4

Lecture: 1
Lab: 3
Tutorial: 0
Projects may involve design of new processes, re-design of existing processes, process simulation and process innovation. Oral presentations and a formal report are required at the end of the term.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 48

PREREQUISITE(S): MINE 455 or permission of the instructor

MINE 459 Risk and Reliability Analysis for Industrial Asset Management, Health & Safety F | 4

Lecture: 3
Lab: 0
Tutorial: 1
This course covers the analytical techniques and tools which form the foundations required for application of the ISO 55000 series of standards for effective life-cycle management of physical assets, as well as the ISO 45000:2018 standard for occupational health and safety management systems. The course uses risk analysis as the primary lens to investigate and evaluate a broad range of industrial challenges, ranging from equipment reliability and maintenance planning strategies, through to identification and mitigation of workplace health and safety hazards. Methodologies covered include Failure Mode, Effects, and Criticality Analysis (FMECA), Reliability Centred Maintenance (RCM), Hazards and Operability Analysis (HAZOP), and Internal Responsibility Systems (IRS) for Safety Management. The role of legislation and regulations is addressed. Selected topics in industrial hygiene, including exposure limits, are also surveyed. Examples and case studies from a variety of industry sectors are used.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 24
Engineering Science 24
Engineering Design 0

PREREQUISITE(S): Completion of 3rd year studies in engineering, or permission of the instructor

MINE 460 Special Topics in Mining Engineering F/W | 4.5

Lecture: 3
Lab: 1.5
Tutorial: 0
This course will change from year to year as subjects of special interest to mining engineers arise, or as special staff are available.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 27

MINE 467 Geostatistics and Orebody Modelling F | 4.5

Lecture: 3
Lab: 1.5

Tutorial: 0
This course introduces those principals of geostatistics used in evaluating grade distribution in orebodies from drillhole data. Basic concepts of spatial distributions, sampling, distance weighted averages, and variograms are covered. Cases from practice will be employed to illustrate concepts. Use of commercially available software to carry out geostatistical calculations and graphical representation will be made. Utilizing these techniques, students will develop a block model of ore grade distribution for an orebody and then apply this model to a mine pre-feasibility study in a subsequent course.

Academic Units:
Mathematics 16
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 24

PREREQUISITE(S): MINE 326, or GEOE 359 or permission of the instructor

MINE 469 DELETED - Stability Analysis in Mine Design F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Application of rock mechanics principles to mine design. Includes planning and execution of geotechnical investigation programs, empirical and analytical methods of stability analysis and support design. Numerical methods are introduced, with emphasis on how to choose among them for particular applications and how to evaluate results. Instrumentation programs are described. Methods are illustrated using case histories. Jan. 2020

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 24

PREREQUISITE(S): MINE 225 or equivalent

MINE 471 Mine-Mechanical Design Project W | 5.5

Lecture: 1
Lab: 1.5
Tutorial: 3
This course involves a design project with emphasis on the mechanical aspects of mine or plant

design and operation. Typical topics include mobile equipment, materials handling, automation, equipment redesign and systems integration.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 0
Engineering Design 48

PREREQUISITE(S): Completion of all 2nd and 3rd year courses or permission of instructor.

MINE 472 Not Offered 2021-2022 Mining Systems, Automation, and Robotics O/L | K3.5

Lecture: No
Lab: No
Tutorial: No
In order to address issues related to safety, productivity, and remote operations, the world's mineral resources industry has been gradually shifting towards the increased use of automated systems and roboticallyenhanced machines. It is important, therefore, that graduate engineers understand how these new technologies work so as to improve and make best use of them. This online course introduces senior students to the fundamental tools and techniques of automation and robotics as applied to modern mining practice. Enrolment is open to students from a range of engineering disciplines. This course provides an introduction to the basics of systems control, examples of how methods of automatic control can be applied to mining equipment and associated industrial vehicles, as well as to the fundamentals of sensing and navigation as applied to the design of robotic mobile equipment.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 18

PREREQUISITE(S): ELEC 443 or MECH 350 or MTHE 332 or permission of the instructor

Mining Technology

MNTC P01 Engineering Mathematics O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0

This course provides a detailed introduction to the fundamentals of calculus and linear algebra as applied to engineering applications. The purpose of the course is to provide a mathematical foundation for students pursuing upper-year engineering-related courses. The course covers topics such as derivatives, implicit differentiation, partial derivatives, integrals, first-order and higher-order linear ordinary differential equations, fundamentals of Laplace transforms, matrices and matrix inverses, solving systems of linear equations, vector spaces, orthogonality, and determinants. Topics are introduced by way of engineering examples. **Available Online.**

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): MNTC P03 and MNTC P04

MNTC P02 Mining Geology O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course provides an overview of geological eras, basic geological structures, mineralogy and mapping technologies as an entry-level course in the Bachelor of Mining Engineering Technology program. The course material is a combination of short videos, required readings and learning activities. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Science 18
Engineering Design 0

MNTC P03 Foundational Mathematics O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course investigates the properties of polynomial, rational, logarithmic, and trigonometric functions. It develops techniques for combining functions and broadens understanding of rates of change while exploring how functions model real-world contexts. Limits of functions and introductory vector manipulation will also be explored. The course content is presented in a

series of purpose-built videos and optional readings. There is an emphasis on time on task in this course and to encourage you to practice your skills, there are graded activities provided each week. **Available Online.**

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

MNTC P04 Calculus O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
Functions, limits, derivatives; optimization, rate problems, exponentials, logarithms, inverse trigonometric functions; exponential growth as an example of a differential equation. Fundamental Theorem of Calculus, Riemann integral; applications to problems involving areas, volumes, mass, charge, work, etc. Some integration techniques. Available Online.

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): MNTC P03

MNTC P05 Foundational Physics O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course serves as a bridge course for students entering the Bachelor of Mining Engineering Technology program from a college diploma program or the workforce. The concepts explored provide learners with the experience and skills in physics that will be necessary for future technical courses in engineering. The course is comprised of a combination of videos, readings and learning activities. Assignments are used to demonstrate proficiency in Newtonian mechanics and electric circuits. **Available Online.**

Academic Units:

Mathematics 0
Natural Sciences 27
Complementary Studies 0
Engineering Science 9
Engineering Design 0

MNTC P06 Foundational Chemistry O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course enables students to deepen their understanding of chemistry through the study of the structure and properties of matter, energy changes and rates of reaction, basic organic chemistry, equilibrium in chemical systems, and electrochemistry. Students will further develop their problem-solving and investigation skills as they investigate chemical processes, and this course will refine their ability to communicate scientific information. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

MNTC P07 Surveying Principles O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course introduces learners to the fundamental principles of surveying. Learners will develop transferable survey computation skills that can be applied using various technologies in diverse environments. In this course, learners will become familiar with differential leveling techniques and basic measurement of angles and distances including calculation techniques. Principles of error propagation and error analysis are also introduced. Finally, a study of modern survey equipment, related concepts and terminology, including Total Stations, Data Collectors, and GPS mapping, will provide learners with an understanding of the current technologies being used in industry today. **Available Online.**

Academic Units:
Mathematics 9
Natural Sciences 0
Complementary Studies 0
Engineering Science 27
Engineering Design 0

MNTC 301 Technical Writing and Communication O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course focuses on the principles and practical applications of technical and business communication. Students apply effective writing strategies to address a variety of audiences. Students plan, outline, write, and revise reader-centered documents and presentations that relate to forms and contexts they will encounter in professional practice**. Available online**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

MNTC 302 Engineering Physics O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course further develops physical concepts of mechanics and electromagnetism in the context of engineering applications. The first part of the course focuses on the mechanics of solid materials, building upon knowledge of rigid-body mechanics and introducing students to the concepts of material strength and elastic deformation. These concepts will be applied to structural members such as rods, columns, shafts, and beams, with loading conditions such as tension, compression, bending, and torsion. The second part of the course focuses on basic direct-current (DC) electrical circuitry and components including electric motors. Students will study concepts such as voltage, current, resistance, capacitance, and inductance. Simple circuit analysis using Kirchoff's laws will be presented, and the sizing and integration of electric motors both electrically and mechanically will be introduced. Available Online.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 0

PREREQUISITE(S): MNTC P05

MNTC 303 Engineering Chemistry O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
The focus of this course is to survey chemical processes and demonstrate its relationship to current practices in mining technology. Students will examine chemical reactions in terms of mass relationships, chemical equations, chemical equilibrium and acid/base reactions concerning aqueous solutions. The examination of the laws of thermodynamics and the behaviour of gases will be explored to provide the necessary background for calculations applied to ideal and non-ideal vapours and liquids. Principles of chemical kinetics and electrochemical reactions will also be studied. Students will have an opportunity to expand their knowledge of organic chemistry to include properties and reactions of functional groups, naming and recognizing key organic structures and apply this knowledge to hydrometallurgy. Special emphasis will be placed upon chemical extraction methods, instrumental analysis, data manipulation and interpretation of key analytes of interest to the mining industry**. Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 18
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): MNTC P06

MNTC 304 Applied Metrology and Data Analysis O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
The objective of this course is to offer students an introduction to some of the primary tools and techniques of contemporary instrumentation and analysis. An introduction to signal analysis, data acquisition, sampling and quantization, as well as the fundamental statistical techniques necessary to process and analyze measured data with uncertainty is given. The course focuses on applied methods and draws on several examples that demonstrate the use of sensors and data acquisition in mining. **Available Online.**

Academic Units:
Mathematics 18
Natural Sciences 0
Complementary Studies 0
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): MNTC P01, MNTC P05 or APSC 111, APSC 112, APSC 171, APSC 172, and APSC 174

MNTC 305 Introduction to Mining O/L | 4

Lecture: 3
Lab: 0
Tutorial: 0
This course presents an overview of the stages of mining, from exploration and prospecting, through development, exploitation, and finally closure and reclamation. Students are introduced to mine financing, methods and design (both surface and underground), mining operations and planning, services (e.g., rock mechanics, ventilation, drilling and blasting), mineral processing, mining equipment and technologies, as well as social and environmental challenges. Case studies and examples are used to illustrate the fundamentals. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 36
Engineering Design 0

PREREQUISITE(S):
MNTC P02 or APSC 151
EXCLUSION(S): MINE 201

MNTC 306 Mineral Processing Unit Operations O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course focuses on unit operations of mineral processing. Mineral separation processes of a physical and physicochemical nature are studied. Topics include size reduction, classification, flotation, flocculation, gravity concentration, magnetic, electrostatic separations and dewatering. Surface phenomena involving fine particle processing, reagent classifications, flotation machines and circuits, plant practice in ore flotation are discussed. The course content is presented in a series of purpose-built videos and optional material. There is an emphasis on project-based team work in this course. Your instructor will form the Teams at the beginning of Week 2 and the Teams will be kept the same for all three projects during the semester. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 9
Complementary Studies 0

Engineering Science 18
Engineering Design 9

PREREQUISITE(S): MNTC 303 or APSC 131 and APSC 132

MNTC 307 Geomechanics and Ground Control O/L | 4

Lecture: 3
Lab: 0
Tutorial: 0
Rock engineering deals with the design of excavations in rock. In this course, methods of characterizing rock masses will be reviewed with the objective of estimating rock mass strength. This will include field investigation methods and laboratory testing. Methods of estimating and measuring in situ stress conditions will be described. Analytical and numerical methods of assessing stresses around mining excavations are reviewed, with emphasis on how to select appropriate methods of stress analysis. Building on these elements, methods of stability analysis are presented for both open pit and underground mine design applications. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 12

PREREQUISITE(S): MNTC 302 or APSC 182
EXCLUSION(S): MINE 325

MNTC 310 Mining and Society O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course takes a look at the social, economic, environmental, ethical, and technical issues facing the mining industry. An introduction to the mining industry's relation to society will explore the changing context of the mining industry and its evolving practice, identify socio-environmental issues, and describe how governments attempt to regulate the industry. A brief assessment of the concept of corporate social responsibility will assess society need for proper industrial stewardship and identify key roles mining corporations play within their communities. Finally, the course will explore the details of mineral rights and claims, including a review of relevant cultural issues and identification of major stakeholders involved in the process. Students will discuss the practical challenges related to a company's social license to operate. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): MNTC P02 or APSC 151
EXCLUSION(S): MINE 422

MNTC 311 Ore Body Modelling and Resource Estimation O/L | 4.5

Lecture: 3
Lab: 0
Tutorial: 0
This course presents a basic introduction to the use of classical and geostatistical estimation techniques for mineral resource estimation. Students will learn to recognize the geological influences to ore body modelling, apply various estimation methods, produce mineralization reports, and classify the mineral resources and reserves according to accepted internationally recognized methods. The course will also include basic ore exploration and sampling concepts. **Available Online.**

Academic Units:
Mathematics 16
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 24

PREREQUISITE(S): MNTC 304, MNTC 305 or APSC 151
EXCLUSION(S): MINE 467

MNTC 313 Introduction to Programming O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
Students will be introduced to the fundamental concepts of computer programming using both C/C++ and MATLAB. The course will teach computer programming with a focus on practical applications for analyzing data and solving practical mathematical problems. Topics will include basic components of a computer (both hardware and software), memory and variables, expressions, selection structures, loops, arrays, functions, and commonly used algorithms such as sorting and searching. At the end of the course, students will be able to apply computer programming skills to assist in both design and analysis for real-life engineering

applications. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 0

PREREQUISITE(S): MNTC P01
EXCLUSION(S): APSC 143

MNTC 314 Drilling and Blasting O/L | 4

Lecture: 3
Lab: 0
Tutorial: 0
The purpose of the course is to introduce commercial explosives technology and examine blast design and its outcomes. The students will be taught principles of commercial explosives engineering, including detonation theory, calculation of energy and products of detonation, prediction of explosives performance and sensitivity, methods of measuring, predicting and controlling rock fragmentation, throw, damage, vibration, flyrock and air blast and will apply their knowledge to design blasts for open cast and underground operations for both construction and mining applications. Recognizing that drilling is related to blasting, the course will introduce rock breakage by mechanical means as applied to drilling, examine parameters affecting drill performance, and choose drilling equipment for various mining methods. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): MNTC 305 or APSC 111, APSC 112, APSC 171, APSC 172, APSC 174, and APSC 182
EXCLUSION(S): MINE 321

MNTC 316 Ventilation and Hydraulics O/L | 4

Lecture: 3
Lab: 0
Tutorial: 0
This course will provide an overview of fluid mechanics in order to provide a solid foundation for

mine ventilation and mine hydraulics. Students will be able to perform ventilation surveys, analyze existing ventilation networks and design new ventilation networks in accordance with mine regulations and design criteria. New technology for saving energy and reducing emissions will be explored. Mine hydraulics topics such as mine service water distribution, mine drainage and dewatering and backfill distribution will be discussed. Students will be able to perform pipe network analyses and select the appropriate pumps for these applications. **Available Online**.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 18
Engineering Design 18

PREREQUISITE(S): MNTC 302 Engineering Physics O/L | 3MNTC 302, MNTC 304, MNTC 305 or APSC 111, APSC 112, APSC 151, APSC 171, APSC 172 and APSC 174APSC 172 Calculus II W | 3.3
EXCLUSION(S): MINE 339

MNTC 399 Field School I (on site) S | 5

Lecture: 0
Lab: 5
Tutorial: 0
Field School I provides a hands -on laboratory experience for fields related to the third year curriculum. Field school modules include an introduction to laboratory techniques and data analysis, geology and rock mechanics, and ventilation studies. Students will develop practical skills both in laboratory and realistic field scenarios. A focus on occupational health and safety is emphasized throughout.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 20
Engineering Science 40
Engineering Design 0

PREREQUISITE(S): MNTC 301, MNTC 302, MNTC 303, MNTC 304, MNTC 305, MNTC 307 and MNTC 316. Must be registered in the BTECH program or permission of the Department.

MNTC 408 Mine Health and Safety O/L | 3

Lecture: 3
Lab: 0

Tutorial: 0
This course is designed to provide knowledge about industrial health and safety practices, in general, and to relate their applications to the mining industry, in particular. The course will identify fundamental industrial physical and chemical (nontoxicological) hazards and risks and review mitigation strategies. Foundational to the course is the analysis of how a typical mine builds a safety organization. The course will examine the processes and the people that comprise award winning safety programs at top performing mining organizations. Students will explore how to design, organize, implement, and maintain a world class safety program as adapted to the mining environment in today's market. How corporate behavior policies ensure adherence to safe work practices and how risk-based safety procedures will lead to performing a job safely will be discussed. The benefits and challenges of instituting and sustaining a "goal zero" type safety culture will be summarized. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

PREREQUISITE(S):
MNTC 305 or APSC 151

MNTC 409 Mineral Economics O/L | 3.5

Lecture: 3
Lab: 0
Tutorial: 0
Mining companies develop projects and operate mines as part of a global minerals industry. This course first sets the global context, reviewing the history of mineral economics, the nature and components of mineral supply and demand, pricing and markets, and aspects of their role in the global economy. The impact of government policies and international treaties on mining companies and projects is discussed. Building blocks of relevant economic concepts and financial tools are reviewed and applied to structured problems. The estimation of mineral resources and mineral reserves, the feasibility assessment process, and the disclosure of the results of work in these areas under National Instrument 43-101, are reviewed. The valuation of companies and evaluation of projects is covered, as are approaches to addressing risk and uncertainty. Sources and types of funding for companies and projects are introduced. Throughout the course, ways in which sustainability is increasingly being reflected in activities studied in this course are highlighted.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 42
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 221 and MNTC 305, or permission of the Mining Department
EXCLUSION(S): MINE 330

MNTC 413 Surface Mine Planning O/L | 4

Lecture: 3
Lab: 0
Tutorial: 0
This course presents a comprehensive overview of the principal components of surface mine design. Topics include pit limit analysis and economic optimization, haul road design, blast design, and basic stability calculations. Equipment selection and application and mine scheduling techniques will be introduced, including dragline applications. The focus will be on the practical application of design techniques to mine planning, and on the available equipment and methods for field monitoring to provide effective design feedback and support safe operations. **Available Online.**

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 24

PREREQUISITE(S): MNTC 305, MNTC 307, MNTC 311, and MNTC 314 or permission of the Department.
EXCLUSION(S): MINE 341

MNTC 414 Underground Mine Planning O/L | 4

Lecture: 3
Lab: 0
Tutorial: 0
The objective of mine planning is to produce a plan for the extraction of a mineral resource that can be executed safely and for a profit. In this course students will demonstrate that the practice of mine planning varies along a spectrum from long range planning through to short term planning with the distinguishing factor being the required level of detail in the mine plan. In the context of long term planning, students will study underground mine design principles such as mining method selection, mine design methodology, mine scheduling and mineral reserves. A progression towards short term planning will lead to the exploration of topics including underground drill and blast design, ground support requirements, ventilation, backfill and

reconciliation. Modern mine planning practices involve the application of technology to facilitate mine design, optimization and scheduling. These techniques will be discussed and some of the tools being used in the mining industry will be used in this course. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 16
Engineering Design 32

PREREQUISITE(S): MNTC 305, MNTC 307, MNTC 311, and MNTC 314 or permission of the department
EXCLUSION(S): MINE 344

MNTC 415 Metal Extraction Processes O/L | 4

Lecture: 3
Lab: 0
Tutorial: 0
This course covers the fundamental and practical applications of metal extraction processes. An introduction to the chemical production of metals will be provided. Basic processing concepts of hydrometallurgical, pyrometallurgical and electrometallurgical unit operations will be discussed. The properties of solutions relevant to metal extraction are reviewed. Fundamentals of mass and heat balances in metallurgical processes will be covered. Some metal production flowsheets are utilized to illustrate the integration of unit processes required for metal extraction. **Available Online**.

Academic Units:
Mathematics 0
Natural Sciences 12
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): MNTC 303, and MNTC 306, or APSC 131, APSC 132, and APSC 151.
EXCLUSION(S): MINE 451

MNTC 418 Sustainability and the Environment O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course describes the evolution of policies, operational procedures, and management systems

related to sustainability and the social, economic, environmental, ethical, and technical design challenges facing the mining industry. Students will be introduced to a range of complex situations with significant sustainability implications that need to be addressed responsibly during the life cycle of a mine, such as resource, water, and waste management, mining -community relationships, mine closure and rehabilitation, as well as a mine closure's community and environmental implications.**Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 18
Engineering Science 18
Engineering Design 0

PREREQUISITE(S): MNTC 305 or APSC 131, APSC 132,and APSC 151

MNTC 419 Mine Supervision and Project Management O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course presents an introduction to mine supervision; covering the roles and responsibilities of the industrial supervisor including health and safety; technical skills and knowledge and effective communications with different stakeholder levels from front line workers to senior management. The second part of the course will introduce key concepts related to project management including the role of the project manager, identifying requirements and balancing of competing project constraints which include, but are not limited to, scope, schedule, cost, quality, and risk. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): MNTC 305 or APSC 221

MNTC 420 Physical Asset Management O/L | 3

Lecture: 3
Lab: 0

Tutorial: 0
This course represents an introduction to reliability and maintenance of mining-related equipment, encompassing both mobile fleets and static equipment, including processing plants. It introduces the primary types of maintenance policies and key performance indicators for reliability and maintenance. Analytical tools for resource allocation and prioritization, as well as an integrated methodology for developing maintenance strategies are covered. **Available Online.**

Academic Units:
Mathematics n/a
Natural Sciences n/a
Complementary Studies n/a
Engineering Science n/a
Engineering Design n/a

PREREQUISITE(S): MNTC 302 and MNTC 304 or APSC 171, APSC 172, and APSC 182

MNTC 423 Geomatics O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course introduces students to the fundamentals of mine surveying. Basic measurement and calculation techniques are used to measure distances, elevation changes, and coordinates. The principles of measurement theory, as well as error propagation and analysis are explored. The course will include a detailed review of modern survey technologies such as total stations, LiDar, and Global Navigational Surveying System (GNSS) mapping, and their applications being used in industry today. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 36
Engineering Design 0

PREREQUISITE(S): MNTC 304 and MNTC 305

MNTC 498 Capstone Project O/L | 3

Lecture: 3
Lab: 0
Tutorial: 0

The objective of this course is to further develop the student's design, innovation, and professional skills. Working in teams, students will engage in a mining-related real-world design project. Design processes will be applied from problem definition, scheduling, though to exception and validation. Professional engineering skills such as communication, teamwork, project management techniques, engineering economics, ethics, and safety will be integral to the project. The course will culminate in the production of an engineering design report and video presentation of the design. **Available Online.**

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 24

PREREQUISITE(S): MNTC 413, MNTC 414, and MNTC 415. Must be registered in the BTech Program.

MNTC 499 Field School II (on site) S | 5

Lecture: 0
Lab: 5
Tutorial: 0
Field School II builds upon the hands -on laboratory experience begun in Field School I. Modules will include a study of mineral processing unit operations, metal extraction processes, as well as drilling and blasting techniques. Students will develop basic laboratory analytical skills both in lab and field sessions. A focus on safety and occupational health will be maintained throughout.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 20
Engineering Science 40
Engineering Design 0

PREREQUISITE(S): MNTC 301, MNTC 302, MNTC 303, MNTC 304, MNTC 306, MNTC 314, MNTC 408, MNTC 415, and MNTC 423. Must be registered in the BTECH program.

Mathematics and Engineering

BIOM 300 NOT OFFERED 2021-2022 - Modeling Techniques in Biology F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Modeling will be presented in the context of biological examples drawn from ecology and evolution, including life history evolution, sexual selection, evolutionary epidemiology and medicine, and ecological interactions. Techniques will be drawn from dynamical systems, probability, optimization, and game theory with emphasis put on how to formulate and analyze models.

Academic Units:
Mathematics 27
Natural Sciences 9
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 172, APSC 174

MTHE 212 Linear Algebra W | 3.5

Lecture: 3
Tutorial: 0.5
Vector spaces, direct sums, linear transformations, eigenvalues, eigenvectors, inner product spaces, self-adjoint operators, positive operators, singular-value decomposition, minimal polynomials, Jordan canonical form, the projection theorem, applications to approximation and optimization problems.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 174
EXCLUSION(S): MTHE 312 (MATH 312)

MTHE 217 Algebraic Structures with Applications F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
The purpose of the course is to provide an introduction to abstract algebraic systems and to illustrate the concepts with engineering applications. Topics include symbolic logic; switching

and logic circuits; set theory, equivalence relations and mappings; the integers and modular arithmetic; groups, cyclic groups, Lagrange's theorem, group quotients, group homomorphisms and isomorphisms; applications to error-control codes for noisy communication channels.

Academic Units:
Mathematics 30
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 0

PREREQUISITE(S): APSC 174

MTHE 224 Applied Mathematics for Civil Engineers F | 4.2

Lecture: 3
Lab: 0.4
Tutorial: 0.8
The course will discuss the application of linear differential equations with constant coefficients, and systems of linear equations within the realm of civil engineering. Additionally, the course will explore relevant data analysis techniques including: graphical and statistical analysis and presentation of experimental data, random sampling, estimation using confidence intervals, linear regression, residuals and correlation.

Academic Units:
Mathematics 50
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 142 or APSC 143 or MNTC 313, APSC 172, APSC 174
EXCLUSION(S): MTHE 225 (MATH 225), MATH 226, MTHE 235 (MATH 235), MTHE 237 (MATH 237), STAT 267, MTHE 367 (STAT 367)

MTHE 225 Ordinary Differential Equations F/W/S-OL | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
First order differential equations, linear differential equations with constant coefficients, and applications, Laplace transforms, systems of linear equations.

Academic Units:

Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

MTHE 227 Vector Analysis F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Review of multiple integrals. Differentiation and integration of vectors; line, surface and volume integrals; gradient, divergence and curl; conservative fields and potential. Spherical and cylindrical coordinates, solid angle. Green's and Stokes' theorems, the divergence theorem.

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

MTHE 228 Complex Analysis W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Complex arithmetic, complex plane. Differentiation, analytic functions. Elementary functions. Elementary functions. Contour integration, Cauchy's Theorem and Integral Formula. Taylor and Laurent series, residues with applications to evaluation of integrals.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

MTHE 232 Deleted - Differential Equations |

Introduction to ordinary differential equations and their applications to the physical and social sciences. Topics may include: numerical solutions, power series and series solutions, Laplace transforms. - COURSE DELETED 2015-2016

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174
EXCLUSION(S): MTHE 225 (MATH 225), MATH 226, MATH 231, MTHE 235 (MATH 235), MTHE 237 (MATH 237)

MTHE 235 Differential Equations for Electrical and Computer Engineers F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
First order differential equations, linear differential equations with constant coefficients. Laplace transforms. Systems of linear differential equations. Introduction to numerical methods for ODEs. Examples involving the use of differential equations in solving circuits will be presented.

Academic Units:
Mathematics 33
Natural Sciences 0
Complementary Studies 0
Engineering Science 9
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174

MTHE 237 Differential Equations for Engineering Science F | 3.25

Lecture: 3
Lab: 0
Tutorial: 0.25
Topics include models for dynamical systems, classification of differential equations, methods for solving differential equations, systems of equations and connections with Linear Algebra, stability of dynamical systems and Lyapunov's method, the Laplace Transform method, and numerical and computer methods.

Academic Units:
Mathematics 18
Natural Sciences 11
Complementary Studies 0
Engineering Science 10
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172, APSC 174
EXCLUSION(S): MATH 231, MTHE 232 (MATH 232)

MTHE 272 NOT OFFERED 2021-2022 - Application of Numerical Methods W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
An introductory course on the effective use of computers in science and engineering. Topics include: solving linear and nonlinear equations, interpolation, integration, and numerical solution of ordinary differential equations. Extensive use is made of MATLAB, a high level interactive numerical package.

Academic Units:
Mathematics 20
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 11

PREREQUISITE(S): APSC 174 or equivalent (Note: some programming experience is important for the course)
COREQUISITE(S): MTHE 225 or MTHE 235 or MTHE 232 or equivalent

MTHE 280 Advanced Calculus F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Limits, Continuity, C', and linear approximations of functions of several variables. Multiple integrals and Jacobians, Line and surface integrals. The theorems of Green, Stokes, and Gauss.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0

Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 172, APSC 174
EXCLUSION(S): MATH 221, MTHE 227 (MATH 227)

MTHE 281 Introduction to Real Analysis W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Taylor's theorem, optimization, implicit and inverse function theorems. Elementary topology of Euclidean spaces. Sequences and series of numbers and functions. Pointwise and uniform convergence. Power series.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 172

MTHE 312 Deleted - Linear Algebra |

Vector spaces, linear transformations and matrices. Linear equations. Determinants. Eigenvalues and eigenvectors. Normal forms. Linear functions and dual spaces. Bilinear functions, quadratic and hermitian forms. Inner product spaces, the projection theorem and applications to approximation and optimization problems. - COURSE DELETED 2015-2016

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): MTHE 217 (MATH 217) or permission of the instructor

MTHE 326 Functions of a Complex Variable F | 3.5

Lecture: 3
Lab: 0

Tutorial: 0.5
Complex numbers, analytic functions, harmonic functions. Cauchy's theorem. Taylor and Laurent series. Calculus of residues. Rouche's theorem.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): MTHE 280 (MATH 280), MTHE 281 (MATH 281)

MTHE 332 Introduction to Control W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
Modeling control systems, linearization around an equilibrium point. Block diagrams, impulse response, transfer function, frequency response. Controllability and observability, LTI realizations. Feedback and stability, Lyapunov stability criterion, pole placement, Routh criterion. Input/output stability, design of PID controllers, Bode plots, Nyquist plots, Nyquist stability criterion, robust controllers.Laboratory experiments illustrate the control concepts learned in class.

Academic Units:
Mathematics 15
Natural Sciences 5
Complementary Studies 0
Engineering Science 23
Engineering Design 5

PREREQUISITE(S): MTHE 326 (MATH 326)
COREQUISITE(S): MTHE 335

MTHE 333 Deleted - Control-Robotics Lab I |

This laboratory introduces the use of motion control devices such as optical encoders, pulse width amplifiers and armature controlled DC servo motors. The experiments complement the analytical and theoretical work on control taken in other third year courses. Students design and implement proportional, proportional-derivative, and proportional-integral-derivative controllers. - COURSE DELETED 2012-2013

Academic Units:

Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 4
Engineering Design 8

COREQUISITE(S): MTHE 332

MTHE 334 Mathematical Methods for Engineering and Physics F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Banach and Hilbert spaces of continuous- and discrete-time signals; spaces of continuous and not necessarily continuous signals; continuous-discrete Fourier transform; continuous-continuous Fourier transform; discrete-continuous Fourier transform; discrete-discrete Fourier transform; transform inversion using Fourier series and Fourier integrals.

Academic Units:
Mathematics 28
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 0

PREREQUISITE(S): MTHE 212 (MATH 212), MTHE 281 (MATH 281)

MTHE 335 Mathematics of Engineering Systems W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Linear input/output systems and their stability. Frequency-domain and time-domain analysis. Continuous and discrete-time modeling. Fourier, Laplace, and Z-transforms. Sampling and the discrete-time Fourier transform. Applications to modulation of communications signals, filter design, and digital sampling.

Academic Units:
Mathematics 15
Natural Sciences 6
Complementary Studies 0
Engineering Science 10
Engineering Design 11

PREREQUISITE(S): MTHE 334 (MATH 334), MTHE 326 (MATH 326) or MTHE 228 (MATH 228)

MTHE 337 Introduction to Operations Research Models W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Some probability distributions, simulation, Markov chains, queuing theory, dynamic programming, inventory theory.

Academic Units:
Mathematics 18
Natural Sciences 0
Complementary Studies 0
Engineering Science 9
Engineering Design 9

PREREQUISITE(S): APSC 174 , MTHE 367 and permission of the instructor

MTHE 338 NOT OFFERED 2021-2022 - Fourier Methods for Boundary Value Problems F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Methods and theory for ordinary and partial differential equations; separation of variables in rectangular and cylindrical coordinate systems; sinusoidal and Bessel orthogonal functions; the wave, diffusion, and Laplace's equation; Sturm-Liouville theory; Fourier transform techniques.

Academic Units:
Mathematics 28
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 0

PREREQUISITE(S): MTHE 227 (MATH 227) or MTHE 280 (MATH 280), MTHE 237 (MATH 237) or MTHE 225 (MATH 225), or permission of the instructor

MTHE 339 Evolutionary Game Theory W | 3

Lecture: 3
Lab: 0

Tutorial: 0
This course highlights the usefulness of game theoretical approaches in solving problems in the natural sciences and economics. Basic ideas of game theory, including Nash equilibrium and mixed strategies; stability using approaches developed for the study of dynamical systems, including evolutionary stability and replicator dynamics; the emergence of co-operative behaviour; limitations of applying the theory to human behaviour.

Academic Units:
Mathematics 18
Natural Sciences 9
Complementary Studies 9
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): APSC 172 or MATH 120 (or MATH 121); APSC 174 or MATH 110 (or MATH 111) recommended
EXCLUSION(S): MATH 239

MTHE 351 Probability I F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Probability theory: probability models; random variables; jointly distributed random variables; transformations and generating functions. Inequalities and limit laws. Distributions: binomial, Poisson, exponential, gamma, normal. Applications: elementary stochastic processes, time-to-failure models, binary communication channels with Gaussian noise.

Academic Units:
Mathematics 42
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

COREQUISITE(S): MTHE 280
EXCLUSION(S): STAT 251

MTHE 353 Probability II W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Intermediate probability theory as a basis for further study in mathematical statistics and

stochastic processes; probability measures, expectations; modes of convergence of sequences of random variables; conditional expectations; independent systems of random variables; Gaussian systems; characteristic functions; Law of large numbers, Central limit theory; some notions of dependence.

Academic Units:
Mathematics 36
Natural Sciences 0
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): STAT 251 or MTHE 351 (STAT 351), APSC 174, MTHE 281 (MATH 281)

MTHE 367 NOT OFFERED 2021-2022 - Engineering Data Analysis W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Exploratory data analysis -- graphical and statistical analysis and presentation of experimental data. Random sampling. Probability and probability models for discrete and continuous random variables. Process capability. Normal probability graphs. Sampling distribution of means and proportions. Statistical Quality Control and Statistical Process Control. Estimation using confidence intervals. Testing of hypothesis procedures for means, variances and proportions -- one and two samples cases. Liner regression, residuals and correlation. ANOVA. Use of statistical software.

Academic Units:
Mathematics 31
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 0

PREREQUISITE(S): APSC 171, APSC 172
EXCLUSION(S): STAT 261, STAT 263, STAT 266, STAT 267

MTHE 393 Engineering Design and Practice for Mathematics and Engineering W | K4

Lecture: Yes
Lab: Yes
Tutorial: Yes
This is a project-based design course where methods of applied mathematics are used to solve a

complex open-ended engineering problem. The projects involve using system theoretic methods for modeling, analysis, and design applied to engineering problems arising in a variety of engineering disciplines. Students will work in teams and employ design processes to arrive at a solution. The course will include elements of communications, economic analysis, impacts of engineering, professionalism, and engineering ethics.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 12
Engineering Science 0
Engineering Design 36

PREREQUISITE(S): APSC 200 or APSC 202
COREQUISITE(S): MTHE 332, MTHE 335

MTHE 406 NOT OFFERED 2021-2022 - Introduction to Coding Theory F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Construction and properties of finite fields. Polynomials, vector spaces, block codes over finite fields. Hamming distance and other code parameters. Bounds relating code parameters. Cyclic codes and their structure as ideals. Weight distribution. Special codes and their relation to designs and projective planes. Decoding algorithms.

Academic Units:
Mathematics 14
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 10

PREREQUISITE(S): MTHE 217 (MATH 217)

MTHE 418 Number Theory and Cryptography W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Time estimates for arithmetic and elementary number theory algorithms (division algorithm, Euclidean algorithm, congruences), modular arithmetic, finite fields, quadratic residues. Simple cryptographic systems; public key, RSA. Primality and factoring: pseudoprimes, Pollard's rho-method, index calculus. Elliptic curve cryptography.

Academic Units:
Mathematics 18
Natural Sciences 0
Complementary Studies 0
Engineering Science 9
Engineering Design 9

PREREQUISITE(S): MTHE 217 (MATH 217) or MATH 210 or MATH 211 with permission of the instructor

MTHE 430 Modern Control Theory F | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
This course covers core topics in modern control theory: Linearization, existence and uniqueness of trajectories for nonlinear and linear systems, the transition matrix, controllability, observabiity, minimal realizations, feedback stabilization, linear state observers, optimal control theory, the linear quadratic regulator, dynamic programming.

Academic Units:
Mathematics 18
Natural Sciences 6
Complementary Studies 0
Engineering Science 18
Engineering Design 6

PREREQUISITE(S): MTHE 237 (MATH 237), MTHE 212 (MATH 212) or MTHE 312 (MATH 312), MTHE 326 (MATH 326),MTHE 332 (MATH 332), or permission of the instructor

MTHE 433 Continuum Mechanics with Applications W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Continuum mechanics lays the foundations for the study of the mechanical behavior of solids and fluids. After a review of vector and tensor analysis, the kinematics of continua are introduced. Emphasis is given to the concepts of stress, strain and deformation. The fundamental laws of conservation of mass, balances of (linear and angular) momentum and energy are presented together with the constitutive models. Applications of these models are given in the theory of linearized elasticity and fluid dynamics.

Academic Units:

Mathematics 16
Natural Sciences 10
Complementary Studies 0
Engineering Science 10
Engineering Design 0

PREREQUISITE(S): MTHE 237, MTHE 280, or permission of the instructor

MTHE 434 Optimization Theory with Applications to Machine Learning W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Theory of convex sets and functions; separation theorems; primal-dual properties; geometric treatment of optimization problems; algorithmic procedures for solving constrained optimization programs; applications of optimization theory to machine learning.

Academic Units:
Mathematics 15
Natural Sciences 0
Complementary Studies 0
Engineering Science 15
Engineering Design 12

PREREQUISITE(S): MTHE 281 (MATH 281), MTHE 212 (MATH 212), or permission of the instructor

MTHE 437 Topics in Applied Mathematics W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Subject matter to vary from year to year.

Academic Units:
Mathematics 18
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 12

PREREQUISITE(S): Permission of the instructor

MTHE 439 Lagrangian Mechanics, Dynamics, and Control W | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
Geometric modelling, including configuration space, tangent bundle, kinetic energy, inertia, and force. Euler-Lagrange equations using affine connections. The last part of the course develops one of the following three applications: mechanical systems with nonholonomic constraints; control theory for mechanical systems; equilibria and stability.

Academic Units:
Mathematics 20
Natural Sciences 0
Complementary Studies 0
Engineering Science 11
Engineering Design 11

PREREQUISITE(S): MTHE 280 (MATH 280), MTHE 281 (MATH 281), MTHE 237 (MATH 237) or MATH 231, or permission of the instructor

MTHE 454 NOT OFFERED 2021-2022 - Statistical Spectrum Estimation W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Many systems evolve with an inherent amount of randomness in time and/or space. The focus of this course is on developing and analyzing methods for analyzing time series. Because most of the common time--domain methods are unreliable, the emphasis is on frequency--domain methods, i.e. methods that work and expose the bias that plagues most time--domain techniques. Slepian sequences (discrete prolate spheroidal sequences) and multi--taper methods of spectrum estimation are covered in detail.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 12

PREREQUISITE(S): MTHE 353 (STAT 353), MTHE 312 (MATH 312); or MTHE 338 (MATH 338), STAT 251; or STAT 261, MATH 321; or permission or the instructor

MTHE 455 Stochastic Processes and Applications F | 3.5

Lecture: 3
Lab: 0

Tutorial: 0.5
Markov chains, birth and death processes, random walk problems, elementary renewal theory, Markov processes, Brownian motion and Poisson processes, queuing theory, branching processes.

Academic Units:
Mathematics 28
Natural Sciences 0
Complementary Studies 0
Engineering Science 14
Engineering Design 0

PREREQUISITE(S): MTHE 353 (STAT 353) or one of STAT 251, MTHE 351 (STAT 351), ELEC 326 with permission of the instructor

MTHE 472 Control of Stochastic Systems W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course concerns the optimization, control, and stabilization of dynamical systems under probabilistic uncertainty with applications in engineering systems and applied mathematics. Topics include: controlled and control-free Markov chains and stochastic stability; martingale methods for stability and stochastic learning; dynamic programming and optimal control for finite horizons, infinite horizons, and average cost problems; partially observed models, non-linear filtering and Kalman Filtering; linear programming and numerical methods; reinforcement learning and stochastic approximation methods; decentralized stochastic control, and continuous-time stochastic control.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 12
Engineering Design 12

PREREQUISITE(S): MTHE 351 (STAT 351), MTHE 332 (MATH 332), or permission of the instructor

MTHE 474 Information Theory F | 3

Lecture: 3
Lab: 0
Tutorial: 0
Topics include: information measures, entropy, mutual information, modeling of information

sources, lossless data compression, block encoding, variable-length encoding, Kraft inequality, fundamentals of channel coding, channel capacity, rate-distortion theory, lossy data compression, rate-distortion theorem.

Academic Units:
Mathematics 9
Natural Sciences 0
Complementary Studies 0
Engineering Science 17
Engineering Design 10

PREREQUISITE(S): STAT 251 or MTHE 351 (STAT 351) or ELEC 326

MTHE 477 Data Compression and Source Coding W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Topics include: arithmetic coding, universal lossless coding, Lempel-Ziv and related dictionary based methods, rate-distortion theory, scalar and vector quantization, predictive and transform coding, applications to speech and image coding.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 21
Engineering Design 15

PREREQUISITE(S): MTHE 474 (MATH 474)

MTHE 478 NOT OFFERED 2021-2022 - Topics in Communication Theory F/W | 3

Lecture: 3
Lab: 0
Tutorial: 0
Subject matter will vary from year to year. Possible subjects include: constrained coding and applications to magnetic and optical recording; data compression; theory and practice of error-control coding; design and performance analysis of communication networks; and other related topics.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 0
Engineering Science 18
Engineering Design 18

PREREQUISITE(S): Permission of the instructor

MTHE 484 NOT OFFERED 2021-2022 - Data Networks W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course covers performance models for data networking, delay models and loss models; analysis of multiple access systems, routing, and flow control; multiplexing; priority systems; satellite multiple access, wireless networking, wireless sensor networks. Knowledge of networking protocols is not required.

Academic Units:
Mathematics 10
Natural Sciences 0
Complementary Studies 0
Engineering Science 26
Engineering Design 0

PREREQUISITE(S): MTHE 455 (STAT 455) or permission of the instructor

MTHE 493 Engineering Mathematics Project FW | K7.5

Lecture: No
Lab: Yes
Tutorial: Yes
This is the capstone design course for Mathematics and Engineering. Students must work in groups, with a typical group size being between two and four members. Projects are selected early in the year from a list put forward by Mathematics and Engineering faculty members who will also supervise the projects. There is a heavy emphasis on engineering design and professional practice. All projects must be open-ended and design oriented, and students are expected to undertake and demonstrate, in presentations and written work, a process by which the design facets of the project are approached. Projects must involve social, environmental, and economic factors, and students are expected to address these factors comprehensively in presentations and written work. Students are assessed individually and as a group on their professional conduct during the course of the project.

Academic Units:
Mathematics 0
Natural Sciences 0

Complementary Studies 23
Engineering Science 27
Engineering Design 40

MTHE 494 Mathematics and Engineering Seminar F | 3

Lecture: 3
Lab: 0
Tutorial: 0
This is a seminar and course, with an emphasis on communication skills and professional practice. A writing module develops technical writing skills. Students give an engineering presentation to develop their presentation skills. Seminars are given by faculty from the Mathematics and Engineering program, by Mathematics and Engineering alumni on the career paths since completing the program, and by visiting speakers on a variety of professional practice matters, on topics such as workplace safety, workplace equity and human rights, and professional organizations. Open to Mathematics and Engineering students only.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 26
Engineering Science 10
Engineering Design 0

School of Urban and Regional Planning

SURP 844 Real Estate Planning and Development W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course examines real estate market research, project planning finance and development techniques. Residential, retail and office market analysis and development are studies through lectures and case study discussions. Learning materials approx. $24.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): Permission of the instructor

SURP 851 Environmental Policy W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course will examine environmental policies in urban and regional contexts. Tools used by policy makers (e.g. risk assessment and management, quality indices, evaluation, impact assessment, mitigation and compensation) and the constraints they encounter (e.g. uncertainty, legal and administrative constraints and financial costs) will be reviewed. Substantive areas to be examined will be focused on the relationship between the built environment and the quality of air and water as well as the use of land resources. Specific cases will vary from year to year. The scope of policies and readings will range from local to global; integration will be stressed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): Permission of the instructor

SURP 853 Environmental Services W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course will focus on the relationships between environmental services and quality of life in cities and regions. It includes a critical examination of the development, delivery and evaluation of environmental technologies and services. There is an emphasis on water, open space, and solid waste. Case studies and field trips will supplement a lecture/seminar format.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): Permission of the instructor

SURP 855 Environmental Planning and Management W | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course examines planning and management issues and tools in environmental services, such as inventory management, needs assessment, demand management, and investment decisions. The emphasis is on planning, management and financing options and their relationship to land use and urban form.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): Permission of the instructor

SURP 874 Housing Policy F | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course assesses housing policy options and the contributions planners can make to the supply of affordable, adequate and appropriate housing. It presents the many factors influencing the housing market and analyzes public and private initiatives affecting the provision of housing. It shows the interdependence between housing and social service planning and analyzes issues regarding the choices among housing and other social policies. Current policies targeted at specific groups in need of assistance will be reviewed.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 36
Engineering Science 0
Engineering Design 0

Mechatronics & Robotics

MREN 103 Mechatronics Design I W | 4

Lecture: 2
Lab: 2
Tutorial: 0
This course introduces students to basic engineering design methods and tools that are employed

for developing mechatronic and robotic systems. The first part of the course consists of a series of hands-on laboratories that introduce students to core mechatronic and robotic equipment (e.g., sensors, actuators and microcontrollers). In the second part of the course, the knowledge and experience gained in the laboratories is expanded upon and applied to a design project that requires students, working in teams, to configure an autonomous mobile robot to compete on a pre-defined playfield under established competition rules. Throughout the laboratories and project, students will develop and apply basic communication, teamwork, management and professionalism skills and will learn about the impact of their design on society and the environment. The course encourages a sense of creativity and curiosity about robotics and mechatronics engineering work.

Academic Units:
Mathematics 0
Natural Sciences 8
Complementary Studies 18
Engineering Science 6
Engineering Design 16

PREREQUISITE(S): APSC 101

MREN 178 Data Structures and Algorithms W | 4

Lecture: 3
Lab: 0.5
Tutorial: 0.5
This course introduces fundamental structures and algorithms for storing, managing, manipulating and analyzing data. Topics covered include structures, such as multidimensional arrays, linked lists, stacks, queues, deques, asymptotic notation, hash and scatter tables, trees and search trees, heaps and priority queues, graphs, and algorithms such as recursion, branch-and-bound methods, searching, sorting, and probabilistic algorithms. Microcontroller-based laboratory exercises will explore applications of data structures and algorithms, using examples drawn from mechatronics and robotics engineering.

Academic Units:
Mathematics 12
Natural Sciences 0
Complementary Studies 0
Engineering Science 24
Engineering Design 12

PREREQUISITE(S): APSC 143 or MNTC 313
EXCLUSION(S): ELEC 278 or CISC 235

MREN 203 Mechatronics Design II W | 4

Lecture: 2
Lab: 2
Tutorial: 0
This course introduces students to the engineering design process, while integrating knowledge of mechatronic and robotic equipment from MREN 103. The first part of the course will be a paper-based design project, with focus on mechatronics and robotics, that will introduce a formal engineering design process, incorporating elements of problem and scope definition, creativity and idea generation and decision making incorporating economic, societal, and environmental factors. The second part of the course will be prototype-based design project, which includes both hardware and software development, that will provide experience with the design-build-test-fail cycle in engineering design. Students will develop and apply intermediate engineering writing and speaking skills with the emphasis on professional correspondence, engineering reports, oral briefings, and formal oral presentations. Elements of professional practice such as engineering codes, standards and ethics are addressed. The connection between the environment and human activity is explored from a systems perspective.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 15
Engineering Science 0
Engineering Design 33

PREREQUISITE(S): MREN 103

MREN 223 Signals and Systems W | 5

Lecture: 4
Lab: 0.5
Tutorial: 0.5
This course covers the basic concepts and techniques for the modeling and analysis of signals and systems. Topics include signals, system properties, linear time-invariant systems, convolution, impulse response and step response in continuous-time and discrete-time domains; Fourier series; Fourier transforms, spectral analysis; fundamental concepts of filtering in continuous-time and discrete-time domains; AM modulation/demodulation; Laplace transforms, and frequency response; sampling, reconstruction, and digitization; z transform and frequency response. Computational realizations of the analysis tools and their applications are explored in the laboratory using MATLAB.

Academic Units:
Mathematics 15
Natural Sciences 0
Complementary Studies 0
Engineering Science 45

Engineering Design 0

PREREQUISITE(S): ELEC 221, and MTHE 235 or MTHE 237

MREN 230 Thermodynamics and Heat Transfer F | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
This course introduces fundamental thermodynamics and heat transfer concepts needed to analyze thermal systems including: ideal gas laws; work and heat; conservation of energy; thermodynamic properties of pure substances; equations of state; applications to open and closed systems; heat transfer by conduction, convection and radiation. Theory will be complemented with a series of labs that introduce temperature measurement devices and thermal circuit analysis.

Academic Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 15
Engineering Design 0

MREN 241 Fluid Mechanics and Fluid Power W | 3.75

Lecture: 3
Lab: 0.25
Tutorial: 0.5
An introductory course in fluid mechanics with application to fluid power systems. Topics include properties of fluids, fluids at rest, dimensional analysis, the laws of conservation of mass and momentum, Bernoulli's equation for incompressible flow and the energy equation, flow measurements, elementary pipe flow problems including losses due to pumps, valves etc. Laboratories will introduce students to pressure and flow measuring devices, pneumatic and hydraulic components and actuators, and circuit analysis of fluid power systems.

Academic Units:
Mathematics 0
Natural Sciences 30
Complementary Studies 0
Engineering Science 15
Engineering Design 0

PREREQUISITE(S): APSC 111

MREN 303 Mechatronics Design III W | 4

Lecture: 2
Lab: 2
Tutorial: 0
In this course, students will apply their growing technical knowledge of mechatronics and robotics, and the formal engineering design process, to solve a multi-parameter design problem. Working in teams, students will work as a small start-up company that needs to come up with a market-specific technology product, while considering the impact of that product on the society and the environment. Each team must prepare a design proposal that describes their product's market need and high-level specifications, and schedule its milestones for the 12-week term. In addition, teams are required to create a working hardware/software prototype that is demonstrated before an audience at the end of the 12 weeks. Agile project management methodologies are encouraged to iteratively execute, evaluate and correct designs in an efficient way. Teams will demonstrate advanced communication skills by documenting their design process and their product's functional specifications through an online blog and a final report. The teams must have students from both the Mechanical and Electrical streams.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 15
Engineering Science 0
Engineering Design 33

PREREQUISITE(S): MREN 203

MREN 318 Sensors and Electric Actuators F | 5.5

Lecture: 4
Lab: 1
Tutorial: 0.5
This course introduces the basic technologies, structures and operation principles of sensors and electric actuators used in mechatronic systems. The topics include physical principles for the measurement of motion, force, torque, pressure, flow, humidity, radiation (visible and IR) and temperature using analog and digital transducers; methods for signal collection, conditioning and analysis; actuating principles and steady-state characteristics of dc, induction, synchronous, stepper and servo motors, and power transmission systems. Various components will be experimentally tested and analyzed.

Academic Units:
Mathematics 0
Natural Sciences 17
Complementary Studies 0
Engineering Science 31
Engineering Design 18

PREREQUISITE(S): ELEC 271, ELEC 252, and MREN 223

MREN 320 Automation: Machine Design and Control W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
This course introduces fundamental concepts for designing automation machines: designing and specifying machine elements such as cams, gears and drives; designing mechanisms that generate different types of motion for part feeding, orienting, transferring and indexing; controlling motion through pneumatic and electric actuators and PLCs; machine vision systems for inspection; and condition monitoring machines for fault detection and safety. Students will get hands-on experience programming and controlling an automation machine through a series of labs with a tabletop mechatronic workcell.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 16
Engineering Design 26

PREREQUISITE(S): MREN 223, ELEC 443 or MECH 350, or permission of the instructor.

MREN 348 Introduction to Robotics W | 3.5

Lecture: 3
Lab: 0.5
Tutorial: 0
Robotics is an interdisciplinary subject concerning areas of mechanics, electronics, information theory, control systems and automation. This course provides an introduction to robotics and covers fundamental aspects of modeling and control of robot manipulators. Topics include history and application of robotics in industry, rigid body kinematics, manipulator forward, inverse and differential kinematics, workspace, singularity, redundancy, manipulator dynamics, trajectory generation, actuators, sensors, and manipulator position and contact force control strategies. Applications studied using MATLAB/Simulink software simulation and laboratory experiments.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 16
Engineering Design 26

PREREQUISITE(S): MREN 223, ELEC 443 or MECH 350, or permission of the instructor

MREN 403 Mechatronics Design IV FW | 8

Lecture: 2
Lab: 6
Tutorial: 0
In this course, students culminate their learning of mechatronics and robotics, and engineering design, through a team-based capstone design project focused on solving a real-world, industry-level technical challenge, which includes a detailed design phase, as well as robust building and iterative design testing, leading to participation in and external design competition. The course is conducted over two terms. In addition to the design, build and testing of a mechatronics or robotics system, each team is required to demonstrate communication, teamwork, and management skills at a professional level by preparing a formal design proposal, which includes a management plan, providing regular progress reports, and submitting a final design report, together with a formal presentation on the project and its results. Top-placed teams in a preliminary internal design competition will be sponsored to represent Queen's University at an external design competition.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 28
Engineering Science 0
Engineering Design 68

PREREQUISITE(S): Succcessful completion of the 3rd year of the MRE program

MREN 410 Intelligent Machines and Autonomous Systems F | 3.5

Lecture: 3
Lab: 0
Tutorial: 0.5
This course provides students with a working knowledge of methods for design and analysis of robotic and intelligent machines that can think, learn and act in uncertain conditions. Topics include basic principles and methods of machine vision, machine learning and identification, decision-making, and their applications in the design of an autonomous system.

Academic Units:
Mathematics 0
Natural Sciences 0
Complementary Studies 0
Engineering Science 24

Engineering Design 18

PREREQUISITE(S): MREN 178, MREN 223 and ELEC 371, or permission of the instructor

Other Courses

ANAT 100 Anatomy of the Human Body F,W,S | 3.0

Academic Units:

BCHM 310 Deleted-General Biochemistry FW | 9

Lecture: 6
Lab: 1.5
Tutorial: 0
Principles of protein biochemistry, enzymology, and protein engineering. Metabolism of carbohydrates, amino acids and lipids. Role of coenzymes. Generation and storage of metabolic energy. Principles of regulatory mechanisms, membrane structure and function, hormone action, and cellular signalling. NOTE: Course weighting is defined by the Faculty of Arts and Science Deleted Nov. 2018

Academic Units:
Mathematics 0
Natural Sciences 90
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): ENCH 281 (CHEM 281) and CHEM 282, or ENCH 211 (CHEM 211) and ENCH 212 (CHEM 212) and ENCH 245 (CHE
EXCLUSION(S): BCHM 315, BCHM 316

BCHM 410 Deleted-Protein Structure and Function F | 3

Lecture: 3
Lab: 0
Tutorial: 0
This course presents an integrated approach to the study of protein function. Topics include proteomic techniques, mass spectrometry, protein purification, imaging, surface plasmon resonance, calorimetry, bioinformatics and protein evolution, protein modifications and processing, interpretation and applications of 3-D structure, and structure-function relationships. NOTE: Offered jointly with BCHM 810*. Nov. 2018

Academic Units:

Mathematics 0
Natural Sciences 36
Complementary Studies 0
Engineering Science 0
Engineering Design 0

PREREQUISITE(S): Permission of the Department.

BIOL 102 Deleted-Introductory Biology of Cells F | 3

Lecture: 3
Lab: 0.8
Tutorial: 0
An introduction to the basic themes and concepts of modern biology spanning organizational levels from molecules to cells in an evolutionary context. RECOMMENDATION 4U Biology and Chemistry, or equivalent high school background are highly recommended. NOTE: Course weighting is defined by the Faculty of Arts and Science Nov. 2018

Academic Units:
Mathematics 0
Natural Sciences 45
Complementary Studies 0
Engineering Science 0
Engineering Design 0

BIOL 103 Deleted-Introductory to Biology of Organisms W | 3

Lecture: 3
Lab: 0.8
Tutorial: 0
An introduction to the basic themes and concepts of modern biology spanning organizational levels from organisms to ecosystems in an evolutionary context. NOTE: Course weighting is defined by the Faculty of Arts and Science

Academic Units:
Mathematics 0
Natural Sciences 45
Complementary Studies 0
Engineering Science 0
Engineering Design 0

Admission and Fees

Admissions

Information on Admissions

Students who are considering applying to Queen's are directed to Queen's Admission Services at: http://www.queensu.ca/admission. The Admissions website provides information regarding the admission requirements for all undergraduate programs, facilities and services, residences, scholarships and financial assistance.

Campus Visits

Applicants and potential applicants are encouraged to visit the Queen's campus, as well as the Faculty of Engineering and Applied Science. Formal arrangements can be made by contacting engineering.reception@queensu.ca.

Criteria

Admission is offered to the best qualified students applying. Academic success is the primary criterion for admission to Engineering and Applied Science. Students whose academic performance exceeds a required minimum will receive an offer of admission. In all other cases, students will be evaluated on a combination of their academic and non-academic achievements. Submission of a completed Personal Statement of Experience (PSE) form is required for all first year applicants.

Fees

The Board of Trustees reserves the right to make changes in the scale of fees if, in its opinion, circumstances so warrant.

Tuition Fees

Tuition fees are reviewed each year and are dependent on government funding and regulation. Specific information on tuition levels is available on the Web at http://queensu.ca/registrar/financials/tuition-fees. Students are encouraged to become familiar with this information.

Ancillary Fees

Students may be required to pay ancillary fees for course related learning materials, safety equipment and field trips. The maximum estimated compulsory fees for specific academic plans are shown below. Those plans not listed do not have ancillary fees. In most cases the actual cost to individual students will be less than the amount indicated.

First Year	$	109
Geological Engineering[1]		2,825
Mechanical Engineering[2]		100
Mining Engineering[3]		250

[1]See the Geological Engineering website for a breakdown and explanation of costs.

[2]Fee for MECH 370 optional field trip.

[3]To be confirmed prior to start of the Fall term.

Non-compulsory Fees

Academic Appeal Fee will be refunded if appeal is granted.	$40.00	Payable through Student Services. See http://engineering.queensu.ca/Current-Students/Registration-Guide/Academic-Regulation-Requests-Waivers-and-Appeals.html for official form and payment information.
Request for Course Substitution (Letter of Permission) To take a course from another university and substitute the course for credit towards Queen's Engineering Degree.	60.00	Payable through Student Services. See http://engineering.queensu.ca/Current-Students/Registration-Guide/Academic-Regulation-Requests-Waivers-and-Appeals.html for official form and payment information.
Course Description Request	60.00/hr	Payable through Student Services. Contact engineering.reception@queensu.ca to make request and discuss payment.
Document Fee For completion of all documents related to registration at Queen's. Includes documents such as proof of enrolment, degree eligibility.	30.00	Payable through Student Services. Contact engineering.reception@queensu.ca to make request and discuss payment.

Exchange Program Fee	125.00	Payable through Student Services. Contact the International Student Advisor at engineering.intladvisor@queensu.ca for more information.
Exam Rereads Fee will be refunded if the mark increases.	50.00	Payable through Student Services. See http://engineering.queensu.ca/Current-Students/Registration-Guide/Academic-Regulation-Requests-Waivers-and-Appeals.html for official form and payment information.
Internship Program - application fee	35.00	Please contact Micheline Johnston at micheline.johnston@queensu.ca for application and payment information.
Late Application Fee includes late course add/drop, late registration/withdrawal of Supplemental Examinations of J Section Re-write Exams, late Application to Graduate	60.00	Payable through Student Services. See http://engineering.queensu.ca/Current-Students/Registration-Guide/Academic-Regulation-Requests-Waivers-and-Appeals.html for official form and payment information.
Readmission Application Fee	55.00	Payable through Student Services. Contact the Assistant to the Associate Dean (Academic) eng.deanacad.admin@queensu.ca if you have any questions.
Registered Education Savings Plan - form completion Fee includes direct submission of RESP form by registered mail or fax.	30.00	Payable through Student Services. Contact engineering.reception@queensu.ca to make request and discuss payment.
Required to Withdraw Waiver Request	40.00	Payable through Student Services. See http://engineering.queensu.ca/Current-Students/Registration-Guide/Academic-Regulation-Requests-Waivers-and-Appeals.html for official form and payment information.

Supplemental Examinations	300.00	Payable through SOLUS
Extended Program (Section 900/J-Section) & Rewrite Exams:		
Extended Program - Section 900 per course tuition fee[1]	539.63	Payable through SOLUS
Rewrite Exam - per exam fee (Spring term)[2]	300.00 +SAL	Payable through SOLUS
Section 900 or Rewrite Exam - remote exam fee per exam[3]	300.00	Payable through Student Services. Please see http://engineering.queensu.ca/Current-Students/First-Year-Studies/Section900/DetailedInformation.html#Rewrite for more information.
Section 900 or Rewrite Exam - remote exam admin fee[3]	75.00	Payable through Student Services. Please see http://engineering.queensu.ca/Current-Students/First-Year-Studies/Section900/DetailedInformation.html#Rewrite for more information.

[1]The course tuition fee is for the 6-week portion of the course that extends past the end of Winter term, and includes Spring term exams in June.

[2]The Spring exam fees are assessed under the current fee schedule and will be $470.00, plus $10.00. (SAL = Student Assistance Levy) per exam.

[3]Students may choose to write exams in a location other than Kingston. There is a $300 fee per exam plus an administrative fee of $75.00 for one or more exams.

Fees quoted are for domestic students. Fees for International students are higher. Please contact the Registrar's Office or refer to the Guide to Registration and Fees at http://www.queensu.ca/registrar/ for details. In case of differences between the above and the Guide, the fees shown in the Guide shall prevail.

Account Information

Students can use SOLUS to determine their account balances.

Student Services Fee Payments

We do not accept cash payments at any time. Credit card payments may be made in the Faculty of Engineering and Applied Science Online Store https://store.engineering.queensu.ca/.

No form that requires a Student Services payable fee will be processed without payment.

Cheques are to be made out to "Queen's University".

PLEASE DO NOT PROVIDE CREDIT CARD NUMBERS AT ANYTIME, VIA EMAIL.

Debts

Any student with an overdue debt with the University will not be permitted to register or to receive examination results, official transcripts, or marks reports until the outstanding account is settled in full. A Senate Regulation forbids the release of a diploma to a student in debt to the University.

Questions

Questions about fees or charges should be directed to:

Office of the University Registrar
Gordon Hall
Queen's University
Kingston, Ontario
K7L 3N6
Telephone: 613 533-6894

Please refer to the *Guide to Registration and Fees* (http://www.queensu.ca/registrar) for a comprehensive outline of the items referred to above.

Faculty Policies and Regulations

The Faculty of Engineering and Applied Science may be obliged to make changes to the curricula, academic plan descriptions, and course descriptions in this Calendar.

In that case, the corrections will appear in the Minutes of the Faculty Board. In the event of discrepancies between statements that appear on the Faculty Web Sites and the corresponding statements in this Calendar and the Faculty Board Minutes, the latter versions will apply. The following policies and regulations apply to all students registered in the Faculty of Engineering and Applied Science.

The Faculty intends its students to have as much opportunity as possible to develop their individual interests and abilities. Its regulations, academic plans and fields of study have been developed with this goal in mind. The plans, curricula and courses of study are, however, constrained by many factors including accreditation requirements, timetabling, physical facilities, number of staff and the interests of faculty members. The current offerings have been designed in the light of experience and of these restrictions to provide a sufficiently diverse selection to satisfy the interests of most students. However, some students may have valid reasons for seeking variations from the prescribed programs and the regulations include provision for doing so (see Regulations 2d and 2e).

Faculty Policies

All FEAS Policies conform with Senate policies. All Faculty Regulations are approved by Senate. Senate Policies of particular relevance to students in Engineering and Applied Science are outlined below. The relevant links are provided through the Calendar website under "Senate Policies".

Access and Privacy

Student Appeals, Rights and Discipline

Policy on Academic Integrity

Student Access to Final Examination Papers

Confidential Exams

Electronic Information Security Policy Framework

Academic Integrity Policy Statement

Queen's University is dedicated to creating a scholarly community free to explore a range of ideas, to build and advance knowledge, and to share the ideas and knowledge that emerge from a range of intellectual pursuits. Queen's students, faculty, administrators and staff therefore all have responsibilities for supporting and upholding the fundamental values of academic integrity. Academic integrity is constituted by the five core fundamental values of honesty, trust, fairness, respect and responsibility (see http://www.academicintegrity.org/icai/home.php) and by the quality of courage. These values and qualities are central to the building, nurturing and sustaining of an academic community in which all members of the community will thrive. Adherence to the values expressed through academic integrity forms a foundation for the "freedom of inquiry and exchange of ideas" essential to the intellectual life of the University.

Honesty in a University is an essential component in maintaining high ethical standards. In preparing students for the profession of engineering, the Faculty of Engineering and Applied Science must send a clear message that high standards are expected. Consistent with this message, students are entitled to an environment where individual performance can be presented and evaluated as fairly as possible. Courses and assignments vary in the amount of collaborative versus individual work that is expected, and the intention of the instructor must be clear to the student. Similarly, the physical setting for examinations should allow individual work where invigilation need not be intrusive. The type and amount of any information that a student may take into an examination must be clearly known ahead of time and of a nature that can be easily verified.

The detailed Policies and Procedures for Departure from Academic Integrity (DFAI) are on-line at: http://engineering.queensu.ca/policy/Honesty.html

Faculty Regulations

1. **Registration**

    a. A student must register in courses within the first two weeks of the commencement of term.
    b. The addition of a course after the prescribed "add course" deadline requires approval of the course instructor, the department in which the student is registered, and the FEAS Faculty Board Committee.
    c. A student must withdraw from courses within the first two weeks of the commencement of term to avoid financial penalty.
    d. A student may withdraw voluntarily from a Fall Term course or a Winter term course prior to the deadline to drop without faculty permission. If so dropped, the course is removed from student record.
    e. Withdrawal from a course after the prescribed deadline to drop without faculty permission requires the approval of the Undergraduate Chair and the FEAS Faculty Board Committee, and will only be permitted in exceptional circumstances that would prevent the student from dropping the course within the prescribed deadline. Withdrawals such as these will be indicated on the student's transcript by the designation DR (see Regulation 3h).
    f. A student may apply for a change from one FEAS academic plan to another by July 31st for the Fall term and by December 1st for the Winter term. Late requests will be considered until August 15th for Fall term and December 15th for Winter term and will be subject to late application fees. Requests are submitted for the approval of the Associate Dean (Academic).
    g. Students must obtain approval from Student Services, FEAS, to add or drop first year courses.
    h. A student may add an Extended Program offering of a Fall Term course, or apply to rewrite a Fall Term examination, only within the first three weeks after the commencement of Winter Term and may drop such a course only within the first four weeks after the commencement of Winter Term. A student may add an Extended Program offering of a Winter Term course only within the first nine weeks after the commencement of Winter Term and may drop such a course only before the end of regular Winter Term classes.

i. A student who wishes to rewrite second term examinations of the first year when they are offered at the end of the Extended Program may register to do so only within the first two weeks of the Summer Term, and may cancel this registration without faculty permission only within the first three weeks of the Summer Term.

2. **Programs of Study**

   a. Students are responsible for ensuring that their course registrations are accurate and complete, and that the courses in which they register meet the requirements for graduation. Course prerequisites and any restrictions on enrolment should be noted carefully prior to registration. The Undergraduate Chair for the academic plan, or the year advisors in the department, should be consulted whenever requirements are not fully understood.
   b. A student who is registered in the Regular First Year Program for Winter Term courses may register to rewrite the final examination in any failed first year course at the next examination period only if the student's term Grade Point Average (GPA) is 0.7 or higher in both Fall and Winter terms
   c. An upper year student may request an exemption in a course by application to the FEAS Faculty Board Committee or delegate on the basis of knowledge acquired through practical experience or acquired through studies prior to first admission to the FEAS. Approval for a request for a course exemption must be recommended by the course instructor and by the Department, on the basis of a satisfactory assessment of the student's proficiency in the exempted course material. In cases where the student's total units fall below the minimum CEAB requirement, a replacement course of total weight, and CEAB units must be proposed in the exemption application. If the exemption is granted the student must take and pass the specified replacement course.
   d. An upper year student may request permission for substitution of a course in their program by a similar course, either at Queen's or elsewhere, by application to the FEAS Faculty Board Committee. This request must be submitted prior to completing the substitute course. Approval for a request for a course substitution must be recommended by the instructor of the prescribed course and the Department. For courses other than Complementary Studies, the request will normally only be considered if the institution offering the course has an accredited engineering program and if the student has an Engineering Cumulative Grade Point Average (ECGPA) of at least 1.6. If a request to take a substitute course at another institution is approved, the FEAS will issue a Letter of Permission to allow the student to enroll in the course.
   e. A student seeking a degree in FEAS may not receive more than two years of credits for work done in another Faculty or university, and such credits may not encompass more than one half of the courses of the third and fourth years of the program. Additionally, at least one half of the fourth year of the program must be taken at Queen's.

f. Free discipline choice of academic plan (discipline) is only guaranteed during the winter term selection period, and only for students who have passed all their first year courses. In exceptional circumstances (i.e., academic difficulty, please refer to Regulation 10) a student may not be permitted to choose a discipline, and may instead be required to repeat first year

g. A student who has not passed all of the courses of the first year which are specified as prerequisite to any course in the chosen upper year program must, during the next session, follow a special Fall and Winter term program arranged by the Associate Dean. During this session, the student must pass all prerequisite courses or they may be required to withdraw.

h. Students who have not passed important prerequisite courses in the first-year program and/or have a cumulative GPA below 1.6 may be determined to have deficits in the requisite knowledge, which would prevent them from successfully progressing into their upper year programs. These students will be required to remain in the first-year program for the next academic session. During this session, the students will be required to follow a special program (please refer to Regulation 10bii).

3. **Course Weighting**

a. Each course in the Calendar of the Faculty of Engineering and Applied Science is assigned a weight as specified in the Calendar. A weight of 1 unit is given for each 12 lecture hours in a course, with 0.5 units given for every 12 tutorial hours, and 0.5 units for every 12 lab hours. The multiplying factor to convert from "units" to CEAB accreditation units (AUs) is thus equal to the number of weeks in a term, i.e. 1 unit = 12 AUs for a 12-week course. When engineering students take courses outside the FEAS they must use the unit weighting assigned by the Faculty hosting the course.

b. The following table indicates the grading system used in the FEAS, including permitted letter grades, associated grade points, and equivalent percentage marks. If percentage marks are submitted by instructors, these will be converted to letter grades and grade points and will not be used in the evaluation of student progress or academic standing.

Letter Grade	Grade Points	Numeric Equivalent
A+	4.3	90-100%
A	4.0	85-89%
A-	3.7	80-84%
B+	3.3	77-79%

B	3.0	73-76%
B-	2.7	70-72%
C+	2.3	67-69%
C	2.0	63-66%
C-	1.7	60-62%
D+	1.3	57-59%
D	1.0	53-56%
D-	0.7	50-52%
FR	0.0	40-49%
F	0.0	0-39%

c. The Grade Point Averages (GPAs) used in determining a student's standing are calculated by multiplying the grade points earned in a course by the unit value of that course, summing the products so obtained for all the courses in a given period, and dividing this sum by the total number of units attempted during that given period of time over which the GPA is calculated. Each course is only counted once in calculating either the ECGPA or term GPA. When, during the period considered, a course or a course examination is repeated or replaced by a substitution approved by the FEAS Faculty Board Committee, only the most recently obtained mark will be used in calculating the GPA. Changes to the GPA after the assessment period in May will not impact student assessment decisions.

d. The "Academic Year" concludes at the end of winter term, and includes the previous three consecutive terms (summer, fall, winter). The Engineering term GPA is the Grade Point Average of all Queen's courses taken in an Engineering term in an academic year, while the student is registered in the FEAS. Decisions regarding yearly academic progress will be based on term GPA.

e. The Engineering Cumulative Grade Point Average (ECGPA) is the Grade Point Average of all courses taken in the Summer, Fall and Winter terms of all academic years, while the student is registered in the FEAS. Queen's courses taken during the summer term of the academic year will also be included in the ECGPA.

f. For Classes Spring 2022 and earlier only: The Engineering Graduation Grade Point Average (EGGPA) is calculated after all academic plan requirements have been met and follows the same calculation method as the ECGPA, except that it excludes courses that are part of the First Year Curriculum.

g. Academic status of each student is assessed once a year, at the end of the Winter term. Decisions regarding yearly academic progress will be based on the Fall and Winter term GPA and the ECGPA.

h. Non-evaluative grades: The following is a list of the possible non-evaluative grades and their uses.

Incomplete (IN):
Incomplete standing (IN) is a temporary designation normally reserved for cases where students, because of extenuating circumstances beyond their control, have successfully completed the majority of the graded work, but not all course work (which may include, but is not limited to, assignments, projects, quizzes, mid-terms, and final exams). All Incomplete designations require appropriate supporting documentation, and must be approved by the FEAS Faculty Board Committee. Approval of the instructor must be obtained, and a date will be set for the completion of the work (normally within 9 months of approval). An IN designation will revert to the "default grade" submitted by the instructor after the date set for completion of the work. Please see Regulation 4b for further information.

Pass in a Pass/Fail Course (P)
Some courses do not apply letter grades. The outcome is Pass (P) or Fail (F) to reflect whether the student has successfully fulfilled all the requirements. A course that has been designated as Pass/Fail will not be included in the student's GPA but can be counted as credit towards an academic plan.

Dropped (DR)
The Dropped (DR) designation indicates a course that has been dropped after the deadline to drop without faculty permission. This designation can only be applied with approval from the FEAS Faculty Board Committee. For information, please see Regulation 1e.

Failure with Review (FR)
For information, please see Regulation 14 - Supplemental Examinations

Grade Deferred (GD)
The Grade Deferred (GD) designation is a temporary designation used in situations where a student's final grade in a course is being held.

Audit (AU)
The AU designation indicates that a course has been Audited. For information, please see Regulation 16b.

Credit Standing (CR)
Credit standing (CR) is a permanent designation normally reserved for exceptional cases where students, who have completed all of the work for a course, and achieved a passing grade in the course, but due to illness or other extenuating circumstances beyond their control, earned a substantially lower grade than might have been expected. A student seeking credit standing in a course must submit their request (supported by their course instructor) and appropriate supporting documentation to the FEAS Faculty Board Committee for consideration. If the request is granted, the designation CR will appear on the student's transcript in place of a letter grade. CR grades will not be included in the student's GPA, and cannot be reversed to a letter grade. Students may be granted credit standing for a maximum of 18.0 units during their entire program.

4. **Standing in a Course**
    a. The passing grade for a course is D- or above, or P. The basis upon which the final grade is assigned, including the weight given to course work, should be made available to students by the instructor via the course syllabus at the beginning of a course.
    b. If a student is unable to write the final examination or to submit required coursework because of incapacitating illness or other extenuating circumstances, a temporary designation of IN (incomplete) will be recorded for the course on the recommendation of the course instructor, the Undergraduate Chair, and upon approval by the FEAS Faculty Board Committee (see regulation 3h). The submission of a mark of IN must be accompanied by appropriate supporting documentation, and by a proposed date of completion, but no later than 9 months beyond the date of approval. The course for which a mark of IN has been entered will be excluded when calculating the term GPA and Cumulative GPA of the student concerned. An IN on a transcript does not preclude the application of Regulations 2g or 10. An IN designation will revert to the "default grade" submitted by the instructor after the date set for completion of the work.
5. **Conduct and Attendance**
    a. A student may, for any form of departure from Academic Integrity, or misconduct in an academic setting, incur penalties up to and including the requirement to withdraw under Regulation 11.
    b. A student who claims illness, compassionate grounds, or other extenuating circumstances, as a reason for missing any required component of the course other than the final exam is responsible to notify the instructors concerned, and make alternative arrangements. If there is a significant effect on attendance or academic performance such that the student may wish to request an incomplete (IN) grade, a course drop or a late course drop the student is responsible for providing appropriate supporting documentation to the FEAS Faculty Board Committee. Students are encouraged to seek academic adivse from a program or faculty advisor to obtain guidance on the appropriate action, and the relevant documentation requirements. Refer to Academic Regulation 4b for procedures and documentation required to request an incomplete grade.

6. **Examinations**
    a. Students are referred to the Exam Regulations located on the website of the University Registrar.
    b. An in-person, online, or remote exam (proctored or unproctored) final exam may be declared invalid under the circumstances outlined below. Students who had their final exam declared invalid may retake the examination, typically during the September supplemental examination period.

i) Insurmountable technical difficulties outside of the student's control (including but not limited to camera and/or computer malfunction, internet loss, etc.)

> i) The student would normally be eligible to apply for the temporary grade designation of incomplete (IN) in the course until they are able to retake the examination.

ii) Failure to meet or follow the rules and guidelines as outlined in the examination instructions both prior to and during the in-person, online, or remote exam (proctored or unproctored) or take-home examination, if there is no sufficient evidence of a Departure from Academic Integrity (DFAI).

> i) The temporary designation of grade deferred (GD) will be applied to the impacted course until the student completes the examination.
>
> ii) A declaration of an invalid exam does not preclude a DFAI investigation, if sufficient evidence becomes available. For further information, please see the policies on (DFAI).

iii) Students who have recurrent invalid examinations due to circumstances outlined under b) may be subject to further disciplinary action under the Faculty Departure from Academic Integrity policy. For further information, please see the policies on (DFAI).

In cases where another type of assessment is declared invalid under the circumstances outlined in i)- iii) above, mitigating measures will be decided upon by the instructor discretion in consultation with the Associate Dean (Academic).

7. Requirements for Graduation*

To qualify for the degree of Bachelor of Applied Science (B.A.Sc.) in engineering, in the FEAS, a student must, at the end of not more than six active (but not necessarily consecutive) calendar years from date of first registration in the Faculty:

a. have passed all the courses required in the First Year program;

b. have passed all courses required by the academic plan in which they registered;

c. while registered in their engineering program, have passed courses whose units total is not less than the minimum required by the program in which they are registered and each course may be counted only once;

d. have achieved an ECGPA of 1.6 or higher;

e. have successfully completed field and technical excursions required by the department in which he or she is registered;

f. have passed the English Proficiency Test (for Classes 2022 and earlier). Note: students who have not passed the English Proficiency Test as of Fall 2019 will be required to take APSC 199 (English Proficiency for Engineers).

g. have satisfied the minimum curriculum content specified by the CEAB in each content category;

A student who has not completed the degree program in six years will normally be required to withdraw. An extension will normally be granted to students who have completed, or are working on an Internship, Exchange, or are enrolled in a Dual Degree program, or have received accommodation through the Queen's Accessibility Services, or through academic advising. If a student is allowed to continue, on successful appeal of this regulation, their program of study will be reviewed by the Department and the Faculty. As a result of the review, possible changes to the student's required program will include but not be limited to the following:

- Courses which have changed significantly in content may have to be retaken.
- Additional courses which have been added to the degree program may be required for graduation.
- Courses which are no longer part of the degree program may not count toward the degree.

8. **Scholarships**
   a. To be eligible for scholarship awards, a student must take in one session all the courses, including electives, prescribed for the year of the program in which they are registered. An exception will be made if any of these courses have been completed previously with a grade of C- or higher. In that event other courses of equivalent total weight and approved by FEAS Faculty Board Committee for scholarship purposes must be added to the student's program. Substitutions granted under Regulation 2e are also acceptable.
   b. To be eligible for the Dean's Scholars list, a student must achieve a combined term (Fall and Winter) GPA of 3.5 or higher while taking 30 units or higher over the Fall and Winter term. If granted, a Dean Scholars ruling will be added to the student's academic transcript.

9. **Graduation with Honours Standing**
   A student will be granted the status of graduation "with Second Class Honours" if, upon graduation, they have attained either an ECGPA of 2.2 or higher. A student will be granted the status of graduation "with First Class Honours" if, upon graduation, they have attained an ECGPA of 3.5 or more. *(*For Classes Spring 2022 and earlier only*: The Engineering Graduation Grade Point Average (EGGPA) is calculated after all academic plan requirements have been met and follows the same calculation method as the ECGPA, except that it excludes courses that are part of the First Year Curriculum.)*
10. **Academic Probation and Requirement to Withdraw***

Academic Probation

a. Students shall be placed on Academic Probation, at the time of their academic standing assessment, if they:
   i. Have an ECGPA between 0.7 and 1.59.
   ii. Have obtained a term GPA below 1.6 in both the Fall and Winter term.
   iii. Have obtained a term GPA below 0.7 after the Fall or Winter term. At the discretion of the Associate Dean (Academic), these students may be placed on academic probation for the following term and they will be reassessed at the end of that term.
   iv. Have returned to studies after having previously been Required to Withdraw.
   v. Have returned to studies after a voluntary deferral (see reg. 11). These students may also be placed on probation at the discretion of the Associate Dean (Academic) and the student's department.

   In all above cases the academic standing "Placed on Academic Probation" shall be placed on the student's transcript.

b. A student under Academic Probation must follow a special program for the next Engineering Session:
   i. Students placed on academic probation under Regulation 10a must repeat courses specified by the Associate Dean, in consultation with the Undergraduate Chair for the academic plan in which the student is registered.
   ii. The Associate Dean, in consultation with the Undergraduate Chair for the academic plan in which the student is registered, may also specify additional probationary conditions to improve the chances of student success in their program. The total course load for this session must not exceed the AUs prescribed for that year of the program.
c. Any student who is placed on Academic Probation and who fulfills all of their Academic Probation conditions at the time of their next academic standing assessment shall be released from Academic Probation and will be considered in 'good academic standing'.
d. Students on Academic Probation will only be considered for release from probation if they have taken a minimum of 12 units since their previous assessment.

Requirement to Withdraw, with opportunity to be considered for readmission after one year:

e. A student will be required to withdraw for a period of at least one year, and may be considered for readmission only after one year if they:

   i. Have an ECGPA less than 0.7 and/or

   ii. Have a term GPA less than 0.7 in both the Fall and Winter term, or for one term (for students who have completed only one Fall or Winter term) and/or

   iii. Are on Academic Probation under Regulation 10a and do not fulfill all of their conditions of Academic Probation.

The academic standing "Required to Withdraw for a minimum of one year" shall be placed on the student's transcript.

Requirement to Withdraw, with opportunity to be considered for readmission after a minimum of three years:

f. A student will be required to withdraw for a period of three years if they have failed a previous year and they:

   i. Have an ECGPA less than 0.7 and/or

   ii. Have a term GPA less than 0.7 in both the Fall and Winter term, or for one term (for students who have completed only one Fall or Winter term) and/or

   iii. are on Academic Probation under Regulation 10a and do not fulfilled all of their conditions of Academic Probation.

The academic standing "Required to Withdraw for a minimum of three years" shall be placed on the student's transcript.

11. **Withdrawal**
    a. A student experiencing academic difficulty (refer to Regulation 10) may request a deferral of their studies no later than 31 January. The student must apply for a resumption of studies to the FEAS. Students returning to studies after a deferral will be placed on academic probation for their returning year.
    b. The Faculty Board may, at any time, require a student whose conduct, attendance, or work is deemed unsatisfactory, to withdraw or may recommend to Senate a student's dismissal. The student must reapply in order to be considered for readmission to the FEAS.
    c. A student who defers their program for any reason, or is not registered in the FEAS for twelve consecutive months, must reapply in order to be considered for readmission/resumption of studies.
12. **Readmission**
    a. A student applying for readmission after a failed year must present evidence that they are likely to succeed in completing the degree in the program for which

readmission is sought. The student shall not be readmitted unless the Associate Dean (Academic) is satisfied that this evidence, together with the student's academic record at Queen's, indicates probable success in completing the degree, and that space is available in the required program. A failed year or a withdrawal from a program in engineering at another university will be treated as if it had occurred at Queen's University.

b. A student readmitted to the program may, at the discretion of the Associate Dean (Academic) and the student's Undergraduate Chair, be placed on Academic Probation and subsequently must follow a program constrained by the appropriate requirements outlined under Regulation 10b. In addition, during the first year of registration following a failed year the total unit weight of courses in the student's program shall not exceed that of the regular program of the failed year. As outlined in Regulation 10f and 10h, students placed on probation after a failed year or following readmission must fulfill all of their conditions of Academic Probation or be required to withdraw.

13. **Review and Rereading of Examination Papers**

Students have the right of access to their final examination papers. As a first step, the student should request an informal review with the instructor concerned, and instructors are strongly encouraged to consent. If the request for an informal review is denied or if the student is not satisfied with the decision, the student may submit a formal exam re-read request to the FEAS. The exam re-read request must be submitted in writing to the FEAS within four weeks of the release of results. The application is to be accompanied by the rereading fee.

(The attention of students is directed to the Senate Policy on Student Access to Final Examinations and to Regulation 14b regarding the deadline for applying to write a supplemental examination).

14. **Supplemental Examinations***

a. A student receiving a grade of FR (Failure with Review) may be permitted, upon formal request to the FEAS, to write a supplemental examination in a failed upper year course offered in the FEAS provided the student has an ECGPA of 1.6 or higher and has obtained a term GPA of 0.7 or higher in the previous Fall and Winter terms. Supplemental examinations will be held at Queen's University in September, typically during orientation week. The privilege of writing these supplemental examinations will be confined to this September week following the session in which the failure occurred, and limited to a maximum of three examinations in the student's academic plan, with no more than two in any calendar year. Supplemental examinations cannot be rescheduled, and there are no provisions for make-ups of the supplemental examinations.

b. A student requesting permission to write a supplemental examination must apply in writing to the FEAS by the specified deadline following the session in which the failure occurred. A student may cancel a request for a supplemental examination and the examination fee will be refunded if written notice of the cancellation is received by the FEAS by the specified deadline following the session in which the failure occurred.

   c. The result obtained on a supplemental examination will be substituted for that of the previous final examination in producing the final grade for the course. A student failing to write a supplemental examination for which they are registered and who has not canceled their registration by the specified date will be assigned a final grade of F on the supplemental examination. The final grade for a course which is based on a supplemental examination will be included in the ECGPA for the next Engineering Session. Supplemental marks will not impact or change any previous student assessment decisions.

15. **Written English Proficiency (Classes 2022 and earlier only)**
    a. A student must, within the first academic term of first registration, take a written English Proficiency Test as specified for students registered in the FEAS.
    b. Upon successful completion of the English Proficiency Test, the designation "English Proficiency Test Passed" will be added to the student transcript.
    c. A student must pass the English Proficiency Test or an equivalent test, approved by the Associate Dean (Academic), to be eligible for graduation.
16. **Special Students**
    a. Students may be allowed to take courses in the FEAS without being registered in an academic plan. Such students are defined as "Special Students" and must apply to the Faculty before taking any courses. A Special Student may apply for admission as a regular student proceeding to a degree but, once admitted as a regular student, a student may not re-register as a Special Student before completing a degree in the FEAS.
    b. Students interested in auditing an Undergraduate FEAS course must apply to the Faculty, and approval is given on a case by case basis and only when there is space in the course (refer to reg. 3h).

* *NOTE:* The following regulations do not apply to Bachelor of Mining Engineering Technology (BTech)
Regulation 1b, Regulation 1f, Regulation 1g, Regulation 2g, Regulation 3a, Regulation 3d, Regulation 3e, Regulation 7, Regulation 10, Regulation 14

17. **Regulations Specific to the Bachelor of Mining Engineering Technology program**

    Students enrolled in the Bachelor of Mining Engineering Technology ("BTech") program have specific Bridge Course requirements, as well as specific regulations relating to Requirements for Graduation (replacing Regulation 7), and Academic Probation and Requirements to Withdraw (replacing Regulation 10). The following Regulations apply to BTech students:

    a. **Bridge Course Requirements - BTech (MINE)**

       Upon admission to the BTech program, each student will be enrolled in specific, required, Bridge courses based on their previous academic history. The required

Bridge courses for each student may be different, and will be determined by the Associate Dean (Academic) in consultation with the Program Chair for the BTech (MINE) program. In order to be admitted into the Year 3 of the BTech (MINE) program, a student must pass each required Bridge course with a minimum grade of C-.

b. **Requirements for Graduation - BTech (MINE)**

To qualify for the degree of Bachelor of Mining Engineering Technology in the FEAS, a student must, at the end of not more than ten calendar years from date of first registration in the Faculty:

i. Have passed all courses required by the BTech (MINE) program
ii. Have achieved an Engineering Cumulative Grade Point Average (ECGPA) of 1.3 or higher
iii. Have successfully completed field and technical excursions required by the BTech Program.
iv. Have passed the English Proficiency Test. Note: students who have not passed the English Proficiency Test as of Fall 2019 will be required to take APSC 199 (English Proficiency for Engineers).

A student who has not completed the degree program within ten years of first registering will normally be required to withdraw. An extension will normally be granted to students who have received accommodation that requires a lighter course load through the Queen's Accessibility Services, or through academic advising. If a student is allowed to continue, on successful appeal of this regulation, his/her program of study will be reviewed by the BTech (MINE) Undergraduate Chair and the Faculty. As a result of the review, possible changes to the student's required program will include but not be limited to the following:

- Courses which are no longer part of the academic plan may not count toward the degree.
- Additional courses which have been added to the degree program may be required for graduation.
- Courses which have changed significantly in content may have to be retaken.

c. Academic Probation and Requirement to Withdraw - BTech (MINE)

Academic Probation

i. A student shall be placed on Academic Probation, at the time of their academic standing assessment, if they:
(1) have an ECGPA of less than 1.3. NOTE: the ECGPA excludes final grades received in Bridge courses.
(2) return to studies after having previously been Required to Withdraw.

The academic standing "Placed on Academic Probation" shall be placed on the student's transcript.

ii. A student under Academic Probation must follow a special program for the next Engineering Session:
(1) Students with an ECGPA less than 1.3, or students returning to studies after being previously Required to Withdraw, must repeat courses specified by the Associate Dean, in consultation with the BTech (MINE) program chair.
(2) The Associate Dean (Academic), in consultation with the BTech (MINE) program chair, may also specify additional probationary conditions to improve the chances of student success. The total course load for the probationary session must not exceed the maximum number of units prescribed for that year of the program.

iii. Any student who is placed on Academic Probation and who fulfills all of their Academic Probation conditions at the time of their next academic standing assessment shall be released from Academic Probation.

iv. If a student is Required to Withdraw at the time of their academic standing assessment but is currently taking a Spring/Summer course at Queen's University, they may complete the term-length course in which they are enrolled, but is then required to withdraw at the end of the term.

Requirement to Withdraw, with opportunity to be considered for readmission after one year:

v. A student whose ECGPA is less than 0.7 at the time of the academic standing assessment has failed the year and is required to withdraw for a period of at least one year, and may be considered for readmission only after one year.

vi. A student who is on Academic Probation under Regulation 18.d (i) at the time of assessment and does not fulfill all of their conditions of Academic Probation is required to withdraw for a period of at least one year and may be considered for readmission only after one year. The academic standing "Required to Withdraw for a minimum of one year" shall be placed on the student's transcript.

Requirement to Withdraw, with opportunity to be considered for readmission after a minimum of three years:

vii. A student who has failed a previous year, or who has been previously Required to Withdraw for academic reasons, and whose ECGPA at the time of their academic standing assessment is less than 0.7 has failed the year and is required to withdraw for a minimum period of three years, and may be considered for readmission only after a minimum of three years.

viii. A student who is on Academic Probation at the time of assessment, does not fulfill all of their conditions of Academic Probation and has previously been required to withdraw, is required to withdraw for a minimum period of three years, and may be considered for readmission only after a minimum of three years. The academic standing "Required to Withdraw for a minimum of three years" shall be placed on the student's transcript.

18. **Regulations specific to the B.A.Sc. with Professional Internship**

Students in second or third year of any Engineering program may enroll in a five-year "Bachelor of Applied Science in Engineering Degree program with Professional Internship."

Students who complete successfully the requirements of the Professional Internship program, upon graduating, will receive the designation "B.A.Sc. with Professional Internship" on their transcript.

The requirements of the Professional Internship program are:

a. Students must register in the Queen's University Internship Program and will be enrolled in specific, required Academic Internship courses, depending upon the duration and timing of their internship.
b. To receive a Professional Internship, students must spend a minimum of 12 months, and a maximum of 16 months on Internship.
c. Students must fulfill the requirements stipulated by their Employment contract, as well as the requirements stipulated by their Academic Internship courses, listed in the FEAS Calendar.
d. A student must be in good academic standing (see Regulation 10) to undertake an Internship. The minimum ECGPA requirement at the time of application is 1.9, and a minimum term GPA of 2.0 in the last active term (excluding Summer term).
e. Undertaking a Professional Internship does not affect in any other way the current academic program of the student – all standard faculty policies apply, with the understanding that students take a minimum of 12 months, and a maximum of 16 months out of their regular academic programs to pursue Professional Internship.

Senate Policies

From time to time, the Senate of the University adopts policies governing administrative and academic affairs of all members of the University Community, including Undergraduate Students in the Faculty of Engineering and Applied Science. These policies can be found on Senate Websites. The most convenient entry to these is the index can be found at Senate and University-wide policies.

Faculty Regulations must conform with Senate policies. All Faculty Regulations are approved by Senate. Digests of some of the Senate Policies of particular relevance to students in Engineering and Applied Science are given here. The date after the title is the year in which the policy was adopted or most recently amended.

Access and Privacy
Student Appeals, Rights and Discipline (2004)
Policy on Academic Integrity
Student Access to Final Examination Papers
Confidential Exams
Electronic Information Security Policy Framework

Awards and Financial Assistance

Prospective Students

Please visit the Awards website.

Student Financial Assistance

Student Awards, as part of the Office of the University Registrar, plays a key role in supporting the University's mission. Our goal is to ensure that all students have the opportunity to attend Queen's, regardless of their personal financial circumstances. To achieve this, a variety of funding sources may be required.

The Student Awards Office is responsible for administering all merit-based undergraduate funding and all need-based funding for both undergraduate and graduate students. Merit-based (scholarship) funding recognizes and rewards students for their achievement, both academic and extra-curricular. Need-based funding (bursaries, awards, work study, loans and grants) is disbursed to students on the basis of demonstrated financial need. Listed directly below is general information as it pertains to the various student financial assistance programs administered by the Student Awards Office. For more detailed information please refer to either the Student Awards website or contact the office.

Awards Officers are available throughout the year to provide financial advising on budgeting and the various options available to assist students with financing their Queen's education.

For further Information:

Office of the University Registrar
Student Awards
Gordon Hall, 74 Union Street
Queen's University
Kingston, Ontario, Canada K7L 3N6
Tel: 613-533-2216
Fax: 613-533-6409
E-mail: awards@queensu.ca
Web: http://www.queensu.ca/studentawards/

Government Student Financial Assistance (Loans and Grants)

The federal and provincial governments provide student financial assistance for Canadian citizens, permanent residents, and protected persons studying at the post-secondary level. This assistance is intended to supplement student and family resources and recipients must demonstrate financial need. This assistance is offered in the form of repayable loans and in some cases may also include a limited amount of grant or bursary funding.

The appropriate provincial or territorial authorities will evaluate student applications and will provide funding. Funding options, eligibility criteria and regulations vary by jurisdiction. Students from Ontario will access government student financial assistance through the Ontario Student Assistance Program (OSAP): osap.gov.on.ca. Students from a province or territory outside Ontario must apply for government student financial assistance through their home province or territory.

Other government student financial assistance programs include:

Canada Study Grant for the Accommodation of Students with Permanent Disabilities

This program is designed to assist disabled students with disability-related costs of equipment and/or services associated with their participation in post-secondary studies. Students must first apply for funding from their applicable government student financial assistance program for the current academic year and must demonstrate financial need. Students must also be registered with the Health, Counselling and Disability Services Office at Queen's University.

OSAP Child-Care Bursary

The OSAP Child-Care Bursary is provided to eligible Ontario students who, in relation to their participation in post-secondary studies, incur child-care costs for three or more children.

Ontario Special Bursary

Ontario students with low income and enrolled in part-time studies (as defined by the government - maximum 59% of a full course load in each term of study) due to family responsibilities or other personal circumstances may be eligible. Students must be enrolled in a program leading to a degree or diploma and generally cannot have a previous post-secondary degree or diploma.

Part-time Canada Student Loan/Canada Study Grant (CSG) Program

Canadian citizens and permanent residents with low income and enrolled in part-time studies (as defined by the government - maximum 59% of a full course load in each term of study) may be eligible. Students must be residents of a province or territory that participates in the Canada Student Loans program. To qualify for the CSG students must be studying part-time due to family responsibilities or other personal circumstances.

Work Study Program

Queen's University and the Government of Ontario fund this program. The objective is to provide an opportunity for students in financial need to receive priority for certain part-time jobs, generally on-campus, during the academic terms. Applications for the Fall-Winter academic session are available in May and applications for the Spring-Summer academic session are available in February.

General Bursaries

Queen's University bursary assistance is granted after the student's own financial contribution to the cost of his/her education, parental assistance, government aid assistance, or a bank line of credit have been exhausted. Financial need is the primary consideration in the granting of a bursary.

In order to be considered for the majority of Queen's bursaries, including the ones specifically pertaining to Engineering and Applied Science students, students need to complete a single General Bursary application form (unless otherwise noted in the terms of the awards), which is available from the Student Awards website. The deadline for this application is 31 October. If a student is not granted an Engineering and Applied Science bursary or award he/she is still eligible to receive General Bursary funds. Funds will be distributed at the beginning of Winter Term. Bursaries and awards are paid to the student's tuition account if a balance is owing, and any remaining funds are paid by cheque or electronic funds transfer. The values of the bursaries and awards are variable, unless otherwise noted. For complete terms of these, and other named bursaries and awards see the Student Awards website.

Short-term Loans

Short-term loans (of 90 days or less) may be granted in emergency situations if a full-time student is experiencing temporary cash-flow difficulties and can provide satisfactory evidence that he/she will have sufficient resources to repay the loan on or before the due date. Short-term loans are approved on the basis of financial need to assist students in meeting those expenses normally incurred in support of attendance at the University during the current academic session.

Entrance Awards

Queen's Entrance scholarships, bursaries and awards are not listed in this Calendar. Details on these awards are available on the Student Awards web-site or in the Viewbook brochure. The Viewbook should be available in the Guidance Offices of secondary schools or may be obtained by writing to the Office of the University Registrar (Admission Services), Queen's University, Kingston, ON K7L 3N6

Scholarships

Queen's upper-year scholarships are generally available to full-time students in their respective faculty/school and who will be returning to full-time studies in the year following the award. For the most part, separate applications are not required. Candidates will be considered for those awards for which they are eligible in competition with all other qualified candidates. In instances where a scholarship application is required, specific instructions about the application process are given in the description of the award.

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Online Undergraduate Courses in Engineering

The Faculty of Engineering and Applied Science (FEAS) at Queen's is committed to providing flexibility and accessibility in our curriculum. As such, we provide one fully online undergraduate program and several fully online courses.

Fully online undergraduate program:

Bachelor of Mining Engineering Technology (online)

Fully online courses available for Bachelor of Mining Technology (BTECH) students (Offered Based on Demand):

- MNTC P01 Engineering Mathematics
- MNTC P02 Mining Geology
- MNTC P03 Foundational Mathematics
- MNTC 313 Introduction to Programming
- MNTC 314 Drilling and Blasting

- MNTC P04 Calculus
- MNTC P05 Foundational Physics
- MNTC P06 Foundational Chemistry
- MNTC P07 Surveying Principles
- MNTC 301 Technical Writing and Communication
- MNTC 302 Engineering Physics
- MNTC 303 Engineering Chemistry
- MNTC 304 Applied Metrology and Data Analysis
- MNTC 305 Introduction to Mining
- MNTC 306 Mineral Processing Unit Operations
- MNTC 307 Geomechanics and Ground Control
- MNTC 310 Mining and Society
- MNTC 311 Ore Body Modelling and Resource Estimation
- MNTC 316 Ventilation and Hydraulics
- MNTC 399 Field School I (on site)
- MNTC 408 Mine Health and Safety
- MNTC 409 Mineral Economics
- MNTC 413 Surface Mine Planning
- MNTC 414 Underground Mine Planning
- MNTC 415 Metal Extraction Processes
- MNTC 418 Sustainability and the Environment
- MNTC 419 Mine Supervision and Project Management
- MNTC 420 Physical Asset Management
- MNTC 423 Geomatics
- MNTC 498 Capstone Project
- MNTC 499 Field School II (on site)

Fully online courses available for Bachelor of Applied Science (BASC) and Letter of Permission students:

- APSC 221 Economics and Business Practices in Engineering (Offered Fall, Winter, Summer)
- APSC 250 NOT OFFERED THIS YEAR -Biology Through an Engineering Lens (Offered in Summer **online**)
- CHEE 302 Technical Entrepreneurship (Offered in **Fall** at **Herstmonceux Castle** and Offered in **Winter online**)
- MECH 221 Solid Mechanics I (Offered in Summer)
- MECH 241 Fluid Mechanics I (Offered in Summer)
- MINE 472 Mining Systems, Automation, and Robotics (Offered in Winter)
- MTHE 225 Ordinary Differential Equations (Offered in Summer)

To apply for registration in an FEAS online course or program:

- Existing Queen's students, please visit SOLUS to enroll.
- Students interested in the BTECH program, please see here
- For non-Queen's undergraduate students applying as a Letter of Permission student, use the Queen's Online Application Portal. See below for further information.

Step-by-Step Letter of Permission Application Guideline for Non-Queen's undergraduate students:

Please follow the step below when applying to Queen's Engineering as a Letter of Permission student:

1. Access the online application portal found here
2. Create an account
3. Under 'External Applicant' select 'Letter of Permission/Non-Degree'
4. Under '1st Program/Plan':
    1. Select 'Non-Degree Faculty of Engineering and Applied Science' as your program
    2. Select 'Engineering Online Letter of Permission' as your plan
    3. Select 'Part Time' as your course load
    4. Indicate the term of study (eg. Summer 2020) under term
5. Enter Personal Details section
6. Review application
7. Attach required documentation
8. Submit application payment
9. Complete Application
10. After you have submitted your application, you will work with the Admissions Office who will review your application and, provided you have accurately completed your application, will issue you an offer of admission.
11. Once you have accepted your offer of admission, the Faculty of Engineering and Applied Science Office will reach out to you to assist you with your course registration.

Application Deadlines for BTECH and Letter of Permission

When the $1^{st}/15^{th}$ fall on a weekend/holiday the opening/closing/document deadline/ will move to the next business day. Applications open at 8:30 am and close at 4:30 pm EST.

Term	**Open**	**Close**	**Document/ LOP and Interest Closing**
Winter	Oct 1st	Dec 1st	Dec 15th
Summer	Feb 1st	Apr 1st	Apr 15th
Fall	June 1st	Aug 1st	Aug 15th
Fall (ASO)	July 1st	Aug 1st	Aug 15th

(ASO: Arts & Science Online)

Important Term Dates

FEAS specific dates: http://calendar.engineering.queensu.ca/content.php?catoid=10&navoid=256

FEAS Sessional dates: Registrar's Office website here

Tuition Fees

Information on tuition fees for Domestic and International students can be found here

Pay Your Tuition

Tuition is generally due on the first day of class. Please make note of the upcoming tuition due dates per term.

To Pay Tuition:

METHOD 1: Credit Card (only available to Distance Students)

- Log in to SOLUS
- Click on the green dollar sign
- Follow the on-screen prompts to complete payment

METHOD 2: Bank Transfer

- Using online or in-person banking, find Queen's University as a Payee
- Use your 8-digit student number as the 'account number'
- Once set up, you can pay this payee using funds directly from your bank account online, in person, or by telephone.
- Please note that some payments can take between 3- 5 business days to reflect in your Queen's account.
- The Office of the Registrar can help with all questions about fees and payments. 613-533-6894 or fees@queensu.ca
- Student Awards can help you with questions about OSAP, financial aid, bursaries and awards. 613-533-2216.

Set up your NetID

- Your NetID is your login for the Queen's online Student Centre. Once you apply, you will receive an email with your student number. You will use this to create your NetID following these steps:
- Go to https://my.queensu.ca
- Click on Don't have a NetID?

- Under Students, click on Activate your NetID
- Record your NetID, you will need it every time you log into SOLUS, OnQ and your Queen's email account.

Access your Queen's Email

As a Queen's student, you have a permanent Queen's email address that consists of your netid@queensu.ca. All communication from Queen's will go to this email address. Check it frequently or consider forwarding it to your most commonly accessed email address.

- Log in to Queen's Email
- click on https://outlook.office.com/owa/?realm=queensu.ca
- enter your Queen's NET ID and password
- click "log in"

Access your Courses (OnQ)

Our online courses are run through OnQ, our online learning platforms.

You will be able to begin your online course on the first day of class (or, in the case of a late enrolment, 48 hours after you enrol in SOLUS) by logging into OnQ. From here you will be able to access the course syllabus, timeline and lesson modules, submit assignments and check your grades. You can also communicate with your instructor, TA, and other students in the course. Your instructor or TA will email you at your Queen's email address within the first week of the term to introduce themselves and the course to you.

- click on https://onq.queensu.ca
- enter your Queen's NET ID and password
- click "log in"

Credit Transfer:

You will need to initiate a request at your home university to have the credit transferred – so you should contact your faculty or department regarding the process and regarding how the grade would show on your transcript.

You will also likely need to request an official Queen's transcript be sent from Queen's as proof – please refer to this page for that process:

Please see the Queen's Registrar's pages regarding the process to ordering an official transcript:

Queen's Registrar

Questions can be directed to the registrar's office at:

- transcpt@queensu.ca

- Phone: (613) 533-2040