DATE: Monday 7 March 2016  
TIME: 10:30 a.m. – 12:00 noon  
PLACE: Needles Hall, Room 3318

AGENDA

<table>
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<td>5a. Two-Year Report – Earth and Environmental Sciences*</td>
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<td>6. Graduate Awards* (Hildebrandt)</td>
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<td>6a. Bruce Mitchell Graduate Scholarship – endowment</td>
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</tr>
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<td>Information</td>
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<tr>
<td>7. Other Business</td>
<td></td>
</tr>
<tr>
<td>8. Next Meeting: Monday 11 April 2016 from 10:30 a.m. to 12 noon in NH 3318</td>
<td></td>
</tr>
</tbody>
</table>

* material attached  
** to be distributed separately  
“SGRC” to be approved on behalf of Senate  
“SEN” to be recommended to Senate for approval

1 March 2016  
Mike Grivicic  
Assistant University Secretary
### 8. Declarations of conflict of interest

#### 8.01
At the beginning of each meeting of Senate or any of Senate’s committees or councils, the chair will call for members to declare any conflicts of interest with regard to any agenda item. For agenda items to be discussed in closed session, the chair will call for declarations of conflict of interest at the beginning of the closed portion of the meeting. Members may nonetheless declare conflicts at any time during a meeting.

#### 8.02
A member shall be considered to have an actual, perceived or potential conflict of interest, when the opportunity exists for the member to use confidential information gained as a member of Senate, or any of Senate’s committees or councils, for the personal profit or advantage of any person, or use the authority, knowledge or influence of the Senate, or a committee or council thereof, to further her/his personal, familial or corporate interests or the interests of an employee of the university with whom the member has a marital, familial or sexual relationship.

#### 8.03
Members who declare conflicts of interest shall not enter into debate nor vote upon the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).

#### 8.04
Where Senate or a committee or council of Senate is of the opinion that a conflict of interest exists that has not been declared, the body may declare by a resolution carried by two-thirds of its members present at the meeting that a conflict of interest exists and a member thus found to be in conflict shall not enter into debate on the specified item upon which they have declared a conflict of interest. The chair will determine whether it is appropriate for said member to remove themselves from the meeting for the duration of debate on the specified item(s).
Present: Pascal Calarco, George Dixon, Bernard Duncker, Lowell Ewert, Jim Frank, Michael Hartz, Anwar Hasan, Bruce Hellinga, Sarah Hildebrandt, Robert Hill, Srinivasan Keshav, Raymond Legge, Maureen Nummelin, Paul Parker, Richard Staines, Mike Stone, Mike Szarka, Aaron Thompson, John Thompson, Lana Vanderlee, Linda Warley

Secretariat: Mike Grivicic

Resources: Jennifer Kieffer, Kerry Tolson

Guests: Trevor Clews

Regrets: Maya D’Alessio, Rhona Hanning, Tim Kenyon, Sepehr Mohaddes, Bruce Muirhead, Tamer Özu, Samantha Shortall

Organization of Meeting: Jim Frank, co-chair of the council, took the chair, and Mike Grivicic acted as secretary. The secretary advised that due notice of the meeting had been given, a quorum was present, and the meeting was properly constituted.

1. DECLARATIONS OF CONFLICT OF INTEREST
Members were asked to declare any conflicts they may have in relation to the items on the agenda. No conflicts were declared.

2. MINUTES OF THE 11 JANUARY 2016 MEETING AND BUSINESS ARISING
It was noted the Yuying Li attended in place of Keshav. Council heard a motion to approve the minutes as amended. Duncker and Legge. Carried. There was no business arising.

3. CO-CHAIRS’ REMARKS
Dixon noted that bidding had commenced for the CFI competition with a ~$32 million total available envelope. As well, the Ontario Research Fund – Research Excellence applications were due recently and a total of $120 million was applied for. Frank noted: new GRADVenture program to help graduate students become better prepared for their professional life after graduate school; six associate deans are working with Kieffer on enrollment planning; graduate enrollments are much improved but still below 2010 levels

4. GRADUATE STUDIES ACADEMIC CALENDAR
Speaking to the PowerPoint presentation, Hildebrandt and Trevor Clews indicated: aim to provide a common look and feel for program pages in graduate calendar; associated to migration to new technology platform; activity includes verification of existing program pages; timelines from inception to prospective completion of calendar refresh; common templates to facilitate ease of use in new system e.g. for program changes.

5. CURRICULAR SUBMISSIONS
   a. Arts. Warley spoke to the submission for Arts and Conrad Grebel University College. Council heard a motion to approve items A-C of the Arts submission. Warley and Parker. Carried. Council heard a motion to approve the submissions to revise the graduate calendar for Arts and Conrad Grebel University College. Warley and Hellinga. Carried.

   b. Conrad Grebel University College. This was handled under item 5(a).

   c. Engineering. Hellinga spoke to the submission and noted that the concerns raised from Mathematics on the data analytics plan have been resolved. Council heard a motion to approve the diploma and courses in the data analytics submission as presented. Hellinga and Hasan. Carried. Council heard a motion to approve the changes in mechanical and mechatronics engineering as presented. Hellinga and Legge. Carried.

   d. Environment. Parker provided an overview of all items in the submission. Council heard a motion to approve item 1(A) as presented. Parker and Stone. Carried. Council heard a motion to approve item 1(B) as presented. Parker and Warley. Carried. Council heard a motion to approve item 1(C) as presented. Parker and Hellinga. Carried. Council heard a motion to approve item 2 as presented. Parker and Hill. Carried.

SGRC 7 March 2016, page 3 of 234
e. Science. Hill provided an overview of all items in the submission. Council heard a motion to approve items 1-3 as presented. Hill and Duncker. Carried. Council heard a motion to approve item 4 as presented. Hill and Duncker. Carried.

f. St. Jerome’s University. Council heard a motion to approve the item as presented. Ewert and Warley. Carried.

6. ACADEMIC PROGRAM REVIEW REPORTS
a. Two-Year Report – Germanic and Slavic Studies. Frank noted this report has been recommended to Senate for approval by Senate Undergraduate Council. Council heard a motion to recommend the report Senate for approval. Warley and Hill. Carried.

b. Augmented Final Assessment Report – Management Sciences. Frank indicated that the report has been revised to better align actions with the recommendations. Warley noted that the content related to some of the issues previously raised are no longer contained in the report, and Frank clarified that the content was related to the reviewer’s report rather than the final assessment report. Council heard a motion to recommend the report Senate for approval. Hellinga and Hasan. Carried.

7. GRADUATE AWARDS

b. Environment Graduate Student Scholarship – operating. Received for information.

8. OTHER BUSINESS
There was no other business.

9. NEXT MEETING
The next meeting will be on Monday 7 March 2016 from 10:30 a.m. to 12 noon in NH 3318.

28 February 2016

Mike Grivicic
Assistant University Secretary
The attached Arts Graduate Affairs Group report was approved by the Arts Faculty Council at the February 9th, 2016 meeting and is now being submitted for approval by the Senate Graduate and Research Council on March 7th, 2016.
CURRICULAR ITEMS for approval [bottom right pagination]

A) Accounting
   New Course: ACC 800 - Directed Readings in Accounting [pg 1]

B) Sociology & Legal Studies
   Grad Calendar Minor Changes (revised) [pg 3]

C) German & Slavic Studies
   Course Revisions: GER792 - Master’s Colloquium [pg 4]
   New Course: GER793 – Knowledge Transfer & Reflection [pg 5]
1) **New Course**

**Course number and title:** ACC 800 Directed Readings in Accounting  
**Grading Basis:** Numerical  
**Course Weight:** 0.50  
**Special topics course:** Yes

**Course Description**

This selected topics course is an intensive reading course on specific topics that are not available in the regular departmental course offerings. The course is supervised by a faculty member and normally requires students to undertake a systematic program of reading leading to the writing of a research paper. The course application form must include a detailed course plan including the description of the course and the method of evaluation. This course does not replace any of the required accounting PhD seminar courses. Only one reading course can count toward the required program courses. Departmental/graduate officer consent is required.

**Rationale**

This course gives students the opportunity to develop in-depth knowledge of the literature in their chosen area of expertise. This course would assist the student in completing their thesis and better equip them for conducting future research in their area of expertise.

**MOTION:** To approve ACC 800 Directed Readings in Accounting

Approved at the School of Accounting and Finance Dec 11, 2015 School Meeting
Faculty: Arts
Effective term: Term/Year Spring 2016

Course ☒ New ☒ Revision ☐ Inactivation ☐
Milestone ☐ New ☐ Revision ☐ Inactivation ☐

Course Subject code: ACC Course number: ACC 800
Course Title (max. 100 characters incl. spaces): Directed Readings in Accounting
Course Short Title (max. 30 characters incl. spaces): Directed Readings Accounting
Grading Basis: NUMERICAL
Course Credit Weight: 0.50
Course Consent Required: ☒ Department

Course Description:
This selected topics course is an intensive reading course on specific topics that are not available in the regular departmental course offerings. The course is supervised by a faculty member and normally requires students to undertake a systematic program of reading leading to the writing of a research paper. This course does not replace any of the required accounting PhD seminar courses. Only one reading course can count toward the required program courses. Departmental/graduate officer consent is required.

Meet Type(s): Reading
Primary Meet Type: Reading

Requisites:

Special topics course: Yes ☒ No ☐
Cross-listed: Yes ☐ No ☒

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request:
This course gives students the opportunity to develop in-depth knowledge of the literature in their chosen area of expertise. This course would assist students in completing their thesis and better equip them for conducting future research in their area of expertise.

Prepared by: Khim Kelly Date: 7-Dec-15
MEMORANDUM

TO: Graduate Affairs Group

FROM: Martin Cooke Associate Chair, Graduate Affairs, Department of Sociology and Legal Studies

DATE: 8 December 2015

RE: Graduate Calendar Minor Changes– New comprehensive exam description (revised)

______________________________________________________________________________

PhD PROGRAM (minor calendar changes)
(3) Under Comprehensive Examinations

Currently:
Composition of Committee: The comprehensive examining committee will consist of three faculty members chosen by the student. Adjunct faculty members may sit as members of comprehensive examining committees.

Proposed change:
Composition of Committee: The comprehensive examining committee will consist of three faculty members, one of whom will serve as the Chair of the committee. The Chair will be chosen by the student, and should be a full-time member of the department, and have Approved Doctoral Dissertation Supervisor (ADDS) status. The two additional faculty members will be chosen by the student in consultation with the committee Chair. Ordinarily, the other two members would also be full-time faculty appointments from the Department. All comprehensive examining committees and Chairs are approved by the Department’s Associate Chair, Graduate Studies.

Rationale:
The rationale for the change in wording is to provide students with more specific information regarding the composition of the Comprehensive Examining Committee. This is revised after discussion at the June 2015 GAG meeting, and further revised (adding ADDS status) after the December SRGC meeting.
Faculty:

Effective term: Term/Year Spring 2016

Course ☒ New ☐ Revision ☒ Inactivation ☐

Milestone ☐ New ☐ Revision ☐ Inactivation ☐

New milestone title:

For course revisions, indicate the type(s) of changes: Credit Weight (e.g. consent, description, title, requisites)

Course Subject code: GER Course number: 792

Course Title (max. 100 characters incl. spaces): Master’s Colloquium

Course Short Title (max. 30 characters incl. spaces):

Grading Basis: CREDIT/NO CREDIT

Course Credit Weight: 0.25

Course Consent Required: ☐

Course Description:

New course description (for revision only):

Meet Type(s): Seminar

Primary Meet Type:

Requisites:

Special topics course: Yes ☐ No ☒

Cross-listed: Yes ☐ No ☒

Course Subject(s) to be cross-listed with and approval status:

Sections combined/held with:

Rationale for request: Credit Weight changed to reflect the equivalent ECTS points in our partner university Mannheim, Germany.

Janet Vaughan

Prepared by: Date: 11-Dec-15
Faculty:
Effective term: Term/Year Spring 2016

Course ☒ New ☒ Revision ☐ Inactivation ☐

Milestone ☐ New ☐ Revision ☐ Inactivation ☐

New milestone title:
For course revisions, indicate the type(s) of changes:
(e.g. consent, description, title, requisites)
Course Subject code: GER Course number: 793
Course Title (max. 100 characters incl. spaces): Knowledge Transfer & Reflection
Course Short Title (max. 30 characters incl. spaces):
Grading Basis: CEDIT/NO CREDIT
Course Credit Weight: 0.25
Course Consent Required: ☐

Course Description:
New course description (for revision only):
The course encompasses two learning elements: A Knowledge Transfer Project and an
Intercultural Reflection. Both elements are designed to encourage reflection on your academic
and experiential learning progress and to engage with a wider audience.
Meet Type(s): Practicum
Primary Meet Type:

Requisites:
Special topics course: Yes ☐ No ☒
Cross-listed: Yes ☐ No ☒

Course Subject(s) to be cross-listed with and approval status:
Sections combined/heldwith:

Rationale for request:
These elements have always been part of the program, but had previously been listed under
“further requirements” for the program. As part of the GSAC project changes, we were asked
to incorporate these aspects into a course, in order to acknowledge time spent on these
learning elements (credit hours), and to accord formal program requirement status to these
elements. This change also brings the credit weighting in line with the weighting given to
these elements at our partner university for the joint degree in Mannheim Germany.

Prepared by: Janet Vaughan Date: 11-Dec-15
MEMO

TO:       Mike Grivicic
          Associate University Secretary

FROM:     B. Hellinga, Associate Dean, Graduate Studies
          Faculty of Engineering

RE:       Senate Graduate and Research Council Meeting

DATE:     February 23, 2016

Faculty of Engineering

Attached are revised Graduate Studies Academic Calendar (GSAC) program pages from the Faculty of Engineering, approved by the Engineering Faculty Council on February 23, 2016. These pages have been moved to a new format as part of the GSAC project to create a new standard template for all graduate programs in the Calendar.

For the program pages listed in section 1, in addition to moving to the new template, changes are being proposed to program requirements. These changes are outlined on the covering program revision forms.

Any changes made to the program pages listed in section 2 are editorial in nature (to fit the new template) and do not represent any change to program requirements.

Please place the following motions on the agenda for the next Senate Graduate and Research Council meeting.

Bruce Hellinga

BH: jec
1) Changes to Existing Programs (for approval)

A) School of Architecture:

Master of Architecture - Water (MArch)
Master of Architecture (MArch) - Co-operative Program
Master of Architecture (MArch)

I. Proposed change: Addition of ARCH 671 as a course requirement for transitional students and deletion of one open graduate elective from the current degree requirements. (Pg 4)

This includes adding ARCH 671 to the course calendar (Pg 7)

Rationale for change: From ARCH memo – “The addition of ARCH 671 as a require course ensures all transitional students in the Master of Architecture are clearly meeting the student performance criteria as outlined in the Canadian Architecture certification Board accreditation guidelines. The deletion of a 0.5 credit open graduate elective maintains the current course load for student and total required credits for the degree.”

II. Proposed change: Addition of accreditation information to official academic calendar information. (Pg 9)

Rationale for change: Information must be on all official calendars as per accrediting body Canadian Architecture Certification Board guidelines.

B) Department of Electrical and Computer Engineering:

Accelerated Master's Program in Electrical and Computer Engineering (Pg 26)

I. Proposed change: Removal of Accelerated Master's Program in Electrical and Computer Engineering page from the GSAC.

Rationale for change: The Accelerated Master’s program is a recruitment tool used in Engineering to attract current undergraduate students to continue their studies in our graduate programs. There is no change in the program itself. The information about the program is better suited to the Engineering website and other recruitment communications, rather than being included in the GSAC.
2) New Graduate Calendar Templates (for approval):

A) Conrad Business, Entrepreneurship and Technology Centre:
   Graduate Diploma (GDip) in Business and Entrepreneurship
   Master of Business, Entrepreneurship and Technology (MBET)

B) Department of Electrical and Computer Engineering:
   Certificate of Completion in Electric Power Engineering
   Doctor of Philosophy (PhD) in Electrical and Computer Engineering - Nanotechnology
   Doctor of Philosophy (PhD) in Electrical and Computer Engineering - Quantum Information
   Doctor of Philosophy (PhD) in Electrical and Computer Engineering
   Graduate Diploma (GDip) in Computer Networking and Security (MEng)
   Graduate Diploma (GDip) in Electric Power Engineering
   Graduate Diploma (GDip) in Management Sciences (in Collaboration with the Department of Management Sciences) (MEng)
   Graduate Diploma (GDip) in Software Engineering (MEng)
   Graduate Diploma (GDip) in Sustainable Energy (MEng)
   Master of Applied Science (MASc) in Electrical and Computer Engineering - Nanotechnology
   Master of Applied Science (MASc) in Electrical and Computer Engineering - Quantum Information
   Master of Applied Science (MASc) in Electrical and Computer Engineering
   Master of Engineering (MEng) in Electrical and Computer Engineering - Electric Power Engineering
   Master of Engineering (MEng) in Electrical and Computer Engineering

C) Department of Mechanical and Mechatronics Engineering:
   Doctor of Philosophy (PhD) in Mechanical and Mechatronics Engineering - Nanotechnology
   Doctor of Philosophy (PhD) in Mechanical and Mechatronics Engineering
   Graduate Diploma (GDip) in Design Engineering (MEng)
   Graduate Diploma (GDip) in Fire Safety (MEng)
   Graduate Diploma (GDip) in Green Energy (MEng)
   Graduate Diploma (GDip) in Green Energy
   Master of Applied Science (MASc) in Mechanical and Mechatronics Engineering - Nanotechnology
   Master of Applied Science (MASc) in Mechanical and Mechatronics Engineering
   Master of Engineering (MEng) in Mechanical and Mechatronics Engineering
MEMORANDUM

TO: Bruce Hellinga, Associate Dean, Faculty Engineering Graduate Studies
FROM: Lola Sheppard, Interim O'Donovan Director, School of Architecture
RE: Minor Modification to MArch degree requirements for transitional students
DATE: January 21, 2016

Dear Professor Hellinga,

The School of Architecture is requesting approval for a minor modification to the degree requirements for transitional students admitted into the Master of Architecture program.

The proposed modification includes the addition of a new (0.5 credit) required core course ARCH 671 - Technical Report and deletion of one (0.5 credit) open graduate elective from the current degree requirements.

The addition of ARCH 671 as a required course ensures all transitional students in the Master of Architecture are clearly meeting the student performance criteria as outlined in the Canadian Architecture Certification Board (CACB) accreditation guidelines. The deletion of a 0.5 credit open graduate elective maintains the current course load for students and total required credits for the degree.

The Faculty members of the School of Architecture approved the above modification on January 21, 2016.

Summary of modifications:

- Addition of new required course ARCH 671 (0.5 credit) as a degree requirement for transitional students in the Master of Architecture program.
- Deletion of one (0.5 credit) open graduate elective from the degree requirements for transitional students in the Master of Architecture program.

Attachments to this memo include ARCH 671 new course form and GSAC program revision form.

Thank you,

Lola Sheppard
Interim O'Donovan Director
School of Architecture

University of Waterloo, School of Architecture, 7 Melville Street South, Cambridge, Ontario, N1S 2H4
Graduate Studies
Program Revision Form

Prior to form submission, review the content revision instructions (forthcoming) and information regarding major/minor modifications. For questions about the form submission, contact Trevor Clews, Graduate Studies Office.

Faculty: Choose an item. Engineering

Program: Master of Architecture, Master of Architecture (WATER), Master of Architecture Co-operative program

Program contact(s) (name): Emily Stafford, Graduate Coordinator

Description of proposed change:

Addition of ARCH 671 – Technical Report (0.5 credit) as a core required course and deletion of one (0.5 credit) open graduate elective in the Master of Architecture degree requirements for transitional students.

*Changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form.

Rationale for change: Implementation of new course ARCH 671 - Technical Report as a required core course ensures all students admitted into the Master of Architecture are meeting student performance criteria as outlined in the Canadian Architecture Certification Board (CACB) accreditation guidelines. Replacing a 0.5 unit open graduate elective with this required course maintains the total required credits for the degree.

Type of modification: Choose an item.

Minor

Effective date: Term: Choose an item. Year: Choose an item.

Fall 2016

Current Graduate Studies Academic Calendar webpage (include the link to the page where the change(s) is to be made):
http://gradcalendar.uwaterloo.ca/page/ARCH-Master-of-Architecture
http://gradcalendar.uwaterloo.ca/page/ARCH-MArch-Water
<table>
<thead>
<tr>
<th>Current Graduate Studies Academic Calendar content:</th>
<th>Proposed Graduate Studies Academic Calendar content:</th>
</tr>
</thead>
<tbody>
<tr>
<td>strikethrough content that is to be deleted</td>
<td>underline content that is to be added</td>
</tr>
<tr>
<td>• ARCH 690 Design Studio</td>
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</tr>
<tr>
<td>• ARCH 673 The Science of the Building Envelope</td>
<td>• ARCH 673 The Science of the Building Envelope</td>
</tr>
<tr>
<td>• ARCH 642 Modern Architecture</td>
<td>• ARCH 642 Modern Architecture</td>
</tr>
<tr>
<td>• ARCH 6XX Open graduate elective</td>
<td>• ARCH 671 Technical Report</td>
</tr>
<tr>
<td>• ARCH 691 Design Studio - Comprehensive Building Design</td>
<td>• ARCH 691 Design Studio - Comprehensive Building Design</td>
</tr>
<tr>
<td>• ARCH 662 Steel &amp; Concrete: Design, Structure and Construction</td>
<td>• ARCH 662 Steel &amp; Concrete: Design, Structure and Construction</td>
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<tr>
<td>• ARCH 640 Contemporary Theory, Culture and Criticism</td>
<td>• ARCH 640 Contemporary Theory, Culture and Criticism</td>
</tr>
</tbody>
</table>

Departmental approval date: **JAN 21 2016**

Reviewed by GSO (for GSO use only): ☐

Faculty approval date: ________________________________

SGRC approval date: ________________________________

Senate approval date (if applicable): ____________________
### Course Information

**Faculty:** Engineering  
**Effective term/year:** Fall 2016

**Course:**  
- New
- Revision
- Inactivation

**Milestone:**  
- New
- Revision
- Inactivation

**New milestone title:** Choose an Item

**For course revisions, indicate the type(s) of changes (e.g. consent, description, title, requisites):**

- **Course Subject code:** ARCH  
- **Choose Subj ENGL:**  
- **PMATH**  
- **Choose Subj PSCI - WS**

**Course number:** 671

**Course Title (max. 100 characters incl. spaces):** Technical Report

**Course Short Title (max. 30 characters incl. spaces):** Technical Report

**Grading Basis:** NUMERICAL

**Course Credit Weight:** 0.50

**Course Consent Required:** N √ Y  
- If Y Choose Type

**Course Description:**

- New course description (for revision only):

  Students Will Investigate And Report On Technical Issues As They Relate To The Development Of The Comprehensive Building Project In The Parallel Design Studio. Innovation And Integration In Architectural Design Will Be Stressed With Respect To Structure, Building Envelope, Environmental Systems, Sustainable Assessment Systems, Health And Life Safety, Movement Systems, Site Planning And The Integration Of Information Technology.

**Meet Type(s):** Seminar  
- Choose Meet Type  
- Choose Meet Type  
- Choose Meet Type

**Primary Meet Type:** Seminar

**Requisites:** Co-requisite ARCH 691

**Special topics course:**  
- Yes  
- No  

**Cross-listed:**  
- Yes  
- No

**Course Subject(s) to be cross-listed with and approval status:**
Sections combined/heldwith:

Rationale for request: Addition of ARCH 671 - Technical Report as a required core course ensures all students admitted into the Master of Architecture are meeting student performance criteria as outlined in the Canadian Architecture Certification Board (CACB) accreditation guidelines. Replacing a (0.5 credit) open graduate elective with this required course maintains the total required credits for the degree.

Prepared by: Emily Stafford

Date: January 15, 2016
Graduate Studies
Program Revision Form

Prior to form submission, review the [content revision instructions (forthcoming)](#) and information regarding [major/minor modifications](#). For questions about the form submission, contact [Trevor Clews](#), Graduate Studies Office.

**Faculty:** Engineering

**Program:** Master of Architecture,
   Master of Architecture (WATER),
   Master of Architecture Co-operative program

**Program contact(s) (name):** Emily Stafford, Graduate Coordinator

**Description of proposed change:**

Addition of accreditation information to official academic calendar information.

*changes to courses and milestones also require the completion/submission of the [SGRC Course/Milestone-New/Revision/Inactivation form](#).*

**Rationale for change:** Information must be on all official calendars as per accrediting body Canadian Architecture Certification Board guidelines.

**Type of modification:** Minor

**Effective date:** Term: Spring  Year: 2016

**Current Graduate Studies Academic Calendar webpage (include the link to the page where the change(s) is to be made):**

- [http://gradcalendar.uwaterloo.ca/page/ARCH-MArch-Water](http://gradcalendar.uwaterloo.ca/page/ARCH-MArch-Water)

<table>
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<th>Proposed Graduate Studies Academic Calendar content: (underline content that is to be added)</th>
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<tr>
<td>The professional Master of Architecture in conjunction with the pre-professional Bachelor of Architectural Studies degree from the University of Waterloo compromises an accredited professional</td>
<td></td>
</tr>
</tbody>
</table>
In Canada, all provincial/territorial associations/institutes/orders recommend a degree from an accredited professional degree program as a prerequisite for licensure. The Canadian Architectural Certification Board (CACB), which is the sole agency authorized to accredit Canadian professional degree programs in architecture, recognizes two types of accredited degrees: the Master of Architecture (M.Arch) and the Bachelor of Architecture (B.Arch). A program may be granted a six-year, three-year, or two-year term of accreditation, depending on its degree of conformance with established educational standards.

Master’s degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree, which, when earned sequentially, comprise an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree."

The program in Architecture at the University of Waterloo received accreditation for a 6-year term by the Canadian Architectural Certification Board (CACB) in 2011.
Master of Architecture - Water (MArch)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The professional Master of Architecture in conjunction with the pre-professional Bachelor of Architectural Studies degree from the University of Waterloo compromises an accredited professional education.

In Canada, all provincial/territorial associations/institutes/orders recommend a degree from an accredited professional degree program as a prerequisite for licensure. The Canadian Architectural Certification Board (CACB), which is the sole agency authorized to accredit Canadian professional degree programs in architecture, recognizes two types of accredited degrees: the Master of Architecture (MArch) and the Bachelor of Architecture (BArch). A program may be granted a six-year, three-year, or two-year term of accreditation, depending on its degree of conformance with established educational standards.

Master’s degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree, which, when earned sequentially, comprise an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.

The program in Architecture at the University of Waterloo received accreditation for a 6-year term by the Canadian Architectural Certification Board (CACB) in 2011.

Program information

• Admit term(s)
  o Fall

• Delivery mode(s)
  o On-campus

• Length of program
  o The Master of Architecture is a two-year degree program. Applicants holding a pre-professional Bachelor of Architectural Studies from the University of Waterloo or equivalent degree can complete degree requirements in a minimum of three terms and, up to a maximum of six terms, for those who wish additional time to complete their Master’s thesis. All other students will be required to complete transitional coursework in the first year to adequately prepare for the final thesis year, and will complete degree requirements in six terms.
• Program type
  o Master’s
  o Collaborative
  o Professional

• Registration option(s)
  o Full-time

• Study option(s)
  o Thesis

Admission requirements

• Minimum requirements
  o A four-year, honours pre-professional undergraduate Architecture degree or professional Bachelor of Architecture degree with a minimum overall average of 75%.
  o Applicants being considered for admission to the Master of Architecture who have not completed three or more years of post-secondary work at a Canadian institution, or at an institution at which English was the language of instruction may be required to verify English Proficiency which may include a written exercise or interview as instructed by the School of Architecture. Details will be communicated when required after initial assessment of applications is complete. This is an additional departmental requirement and not a substitute for the English Language Proficiency Certification.

• Application materials
  o Portfolio
    ▪ Portfolio of design work – uploaded directly to applicant Quest account.
  o Résumé/curriculum vitae
  o Supplementary information form
    ▪ Including a statement of the students proposed research interest.
  o Transcript(s)
    ▪ From each post-secondary institution attended (past or current) showing all courses and marks, along with the transcript legends/keys/grading scales uploaded using Quest. Degree certificates (if obtained) must be uploaded with the transcripts.

• References
  o Number of references: 2
  o Type of references: academic

• English Language Proficiency Certification (ELPC) (if applicable)
Degree requirements

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete the following courses in addition to 2 Water core courses:
    - **Year 1**
      - ARCH 690 Design Studio
      - ARCH 673 The Science of the Building Envelope
      - ARCH 642 Modern Architecture
      - ARCH 6XX Open graduate elective
      - ARCH 691 Design Studio - Comprehensive Building Design
      - ARCH 662 Steel & Concrete: Design, Structure and Construction
      - ARCH 640 Contemporary Theory, Culture and Criticism
    - **Year 2: Fall**
      - ARCH 692 Thesis Research and Design Studio I
      - ARCH 610 Architectural Research and Analysis
      - ARCH 6XX Open graduate elective
    - **Year 2: Winter**
      - ARCH 693 Thesis Research and Design Studio II
      - ARCH 655 Architectural Professional Practice: Ethics, Business, Legal Issues, and Contract Administration
      - ARCH 6XX Open graduate elective
    - **Year 2: Spring**
      - ARCH 6XX Open graduate elective
  - Students are encouraged to use elective courses to explore areas of specialization in support of their thesis research. 1 half (0.50) credit may be an independent Reading Course. Up to one half (0.50) credit elective may be taken in other departments. 1 half (0.50) WATER credit can be counted to fulfill one half (0.50) MArch elective requirement.
  - **Water core courses:**
    - WATER 601 Integrated Water Management
    - WATER 602 Integrated Water Management Project
  - The Water core courses are designed to provide fundamental multidisciplinary knowledge and experience to complement the student’s specialist courses and water-related research.
  - The Department will determine whether or not collaborative program courses can be used as electives. It is therefore possible that students will need to take additional courses in order to meet the specific requirements of the program.

- **Master’s Thesis in Design**
Students must undertake and complete a research and design thesis (in Year 2: Spring). The thesis is developed within ARCH 692 and ARCH 693 and completed within the spring term. The thesis is supervised by a faculty advisor, and supported by a committee of one to two additional faculty members. The thesis must be presented and defended successfully before an Examining Committee composed of a minimum of the student's supervisor, one committee member and one reader as per the requirements listed in the Graduate Studies Academic Calendar.

School of Architecture website
• The University of Waterloo offers a unique research-based Masters and Doctor of Philosophy (PhD) collaborative program in Water. This program, jointly offered by ten departments across the Faculties of Arts, Engineering, Environment, Mathematics and Science, is intended to promote multi- and inter-disciplinary perspectives related to water. The goal of the program is to supplement disciplinary (specialist) training offered in individual departments with perspectives from a variety of water-related disciplines. Students graduating from the collaborative program will be better equipped to work in multidisciplinary teams to solve increasingly complex water issues.

The over 130 faculty members involved in water research at the University of Waterloo represent international excellence and leadership in the field. The faculty cohort includes a Canada Excellence Research Chair, eight Canada Research Chairs, two NSERC Industrial Research Chairs and several University Chairs. The University's water programs are diverse and collectively comprehensive, creating a dynamic research and learning environment. Core disciplinary expertise includes:

Hydrological (groundwater, surface water) science and engineering;
Water/wastewater treatment and technology;
Ecohydrology;
Aquatic ecology and ecotoxicology;
Water management, policy and governance.

The collaborative program in Water represents tremendous opportunity for graduate students to train within their chosen disciplines while being exposed to perspectives of water research, innovation and management from other fields.

• Admissions Requirements

Interested students should apply to the collaborative program in Water in one of the following departments/schools via the regular university application process:

Applied Mathematics
Architecture
Biology
Chemical Engineering
Civil and Environmental Engineering
Earth and Environmental Sciences
Economics
Environment and Resource Studies
Environment, Enterprise and Development
Geography and Environmental Management

The collaborative program is available to students who are applying to thesis or major paper-based research programs in the home department and whose program of study will have a substantial focus on water. Admission requirements are the same as home department programs, who must approve the application. Students will be required to submit a brief statement of their research interests in water with their application.

- Students must fulfill all of the requirements of their home department, including any specific courses, thesis or seminar milestones, and all of the requirements of the Water program. Whether or not collaborative program courses can be used as electives in the home department will be determined by the department, and may differ from department to department. It is therefore possible that students will need to take additional courses beyond those prescribed by the home department in order to meet the specific requirements of the Water program.

- Students in the Master of Architecture (Water) collaborative program must complete the degree requirements indicated below in addition to two core courses: WATER 601 and WATER 602.

- Research Seminar
  Students will make a formal presentation on their research at an annual symposium or other designated event. This will be an opportunity to interact with a very broad multidisciplinary audience that crosses all areas of research in the collaborative programs.

- Other opportunities
  Students enrolled in the collaborative program will be offered other learning opportunities, such as participation in seminars and workshops and access to visiting fellows and scholars, which will enhance the learning experience.

- Applying for the collaborative program in Water
  For more information about the collaborative Water graduate programs, please contact the Graduate Studies Coordinator of a participating department or:

  Dr. Mark Servos
  Program Director
  Phone: 519-888-4567 x36034
  Email: mservos@uwaterloo.ca

  Interested students should visit the Graduate Studies Office website.
Master of Architecture (MArch) - Co-operative Program

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The professional Master of Architecture in conjunction with the pre-professional Bachelor of Architectural Studies degree from the University of Waterloo compromises an accredited professional education.

In Canada, all provincial/territorial associations/institutes/orders recommend a degree from an accredited professional degree program as a prerequisite for licensure. The Canadian Architectural Certification Board (CACB), which is the sole agency authorized to accredit Canadian professional degree programs in architecture, recognizes two types of accredited degrees: the Master of Architecture (MArch) and the Bachelor of Architecture (BArch). A program may be granted a six-year, three-year, or two-year term of accreditation, depending on its degree of conformance with established educational standards.

Master’s degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree, which, when earned sequentially, comprise an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.

The program in Architecture at the University of Waterloo received accreditation for a 6-year term by the Canadian Architectural Certification Board (CACB) in 2011.

Program information

- Admit term(s)
  - Fall

- Delivery mode(s)
  - On-campus

- Length of program
  - The Master of Architecture is a two-year degree program. Applicants holding a pre-professional Bachelor of Architectural Studies from the University of Waterloo or equivalent degree can complete degree requirements in a minimum of three terms and, up to a maximum of six terms, for those who wish additional time to complete their Master’s thesis. All other students will be required to complete transitional coursework in the first year to adequately prepare for the final thesis year, and will complete degree requirements in six terms.
• Program type
  o Master’s
  o Co-operative
  o Professional

• Registration option(s)
  o Full-time

• Study option(s)
  o Thesis

Admission requirements

• Minimum requirements
  o A four-year, honours pre-professional undergraduate Architecture degree or professional Bachelor of Architecture degree with a minimum overall average of 75%.
  o Applicants being considered for admission to the Master of Architecture who have not completed three or more years of post-secondary work at a Canadian institution, or at an institution at which English was the language of instruction may be required to verify English Proficiency which may include a written exercise or interview as instructed by the School of Architecture. Details will be communicated when required after initial assessment of applications is complete. This is an additional departmental requirement and not a substitute for the English Language Proficiency Certification.

• Application materials
  o Portfolio
    ▪ Portfolio of design work – uploaded directly to applicant Quest account.
  o Résumé/curriculum vitae
  o Supplementary information form
    ▪ Including a statement of the students proposed research interest.
  o Transcript(s)
    ▪ From each post-secondary institution attended (past or current) showing all courses and marks, along with the transcript legends/keys/grading scales uploaded using Quest. Degree certificates (if obtained) must be uploaded with the transcripts.

• References
  o Number of references: 2
  o Type of references: academic

• English Language Proficiency Certification (ELPC) (if applicable)
Degree requirements

The Master of Architecture curriculum covers six key areas: Design; History; Theory; Building Technology; Media and Methods; Professional Practice.

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete the following courses:
    - **Year 1:**
      - ARCH 690 Design Studio
      - ARCH 673 The Science of the Building Envelope
      - ARCH 642 Modern Architecture
      - ARCH 6XX Open graduate elective
      - ARCH 691 Design Studio - Comprehensive Building Design
      - ARCH 662 Steel & Concrete: Design, Structure and Construction
      - ARCH 640 Contemporary Theory, Culture and Criticism
      - Co-op/Graduate Research Assistantship
    - **Year 2:** Fall
      - ARCH 692 Thesis Research and Design Studio I
      - ARCH 610 Architectural Research and Analysis
      - ARCH 6XX Open graduate elective
    - **Year 2:** Winter
      - ARCH 693 Thesis Research and Design Studio II
      - ARCH 655 Architectural Professional Practice: Ethics, Business, Legal Issues, and Contract Administration
      - ARCH 6XX Open graduate elective
    - **Year 2:** Spring
      - ARCH 6XX Open graduate elective
  - Students are encouraged to use elective courses to explore areas of specialization in support of their thesis research. Up to 1 half (0.50) credit elective may be taken in other departments. 1 half (0.50) course may be an independent Reading Course.

- **Graduate Studies Work Report**

- **Master’s Thesis in Design**
  - Students must undertake and complete a research and design thesis (in Year 2: Spring). The thesis is developed within ARCH 692 and ARCH 693 and completed within the spring term. The thesis is supervised by a faculty advisor, and supported by a committee of one to two additional faculty members. The thesis must be presented and defended successfully before an Examining Committee composed of a minimum of the student's
supervisor, one committee member and one reader as per the requirements listed in the Graduate Studies Academic Calendar.

School of Architecture website
The University of Waterloo offers a master's program leading to the Master of Architecture (MArch) professional degree. This program is designed to prepare students for professional qualification as architects. The Master of Architecture program combines elements of a professional master's program and a research-oriented master's program. It offers preparation for entry into the profession of architecture (together with an extension of the knowledge base required of practicing professionals) to students with a pre-professional undergraduate degree in Architecture, such as a Bachelor of Architectural Studies. The program is designed to develop the skills and intellectual curiosity required for a leadership role in the profession and in society, and for entry into doctoral studies. The Master’s Thesis, the core academic component of the program, will develop research and analytical/interpretive skills, as well as design skills - i.e., the synthetic skills of architecture.

Referees will be emailed to complete and submit the official University of Waterloo Graduate Studies Reference form.

Applicants who have not completed three or more years of post-secondary work at a Canadian institution, or at an institution at which English was the language of instruction, will be required to provide certification of English language proficiency. Information about accepted examinations of English Language can be found on the English Language Proficiency page.

Refer to the Discover Graduate Studies website for complete information on admission requirements and application process.

The Master of Architecture degree requirements are as follows:
Master of Architecture (MArch)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The professional Master of Architecture in conjunction with the pre-professional Bachelor of Architectural Studies degree from the University of Waterloo compromises an accredited professional education.

In Canada, all provincial/territorial associations/institutes/orders recommend a degree from an accredited professional degree program as a prerequisite for licensure. The Canadian Architectural Certification Board (CACB), which is the sole agency authorized to accredit Canadian professional degree programs in architecture, recognizes two types of accredited degrees: the Master of Architecture (MArch) and the Bachelor of Architecture (BArch). A program may be granted a six-year, three-year, or two-year term of accreditation, depending on its degree of conformance with established educational standards.

Master’s degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree, which, when earned sequentially, comprise an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.

The program in Architecture at the University of Waterloo received accreditation for a 6-year term by the Canadian Architectural Certification Board (CACB) in 2011.

Program information

- Admit term(s)
  - Fall

- Delivery mode(s)
  - On-campus

- Length of program
  - The Master of Architecture is a two-year degree program. Applicants holding a pre-professional Bachelor of Architectural Studies from the University of Waterloo or equivalent degree can complete degree requirements in a minimum of three terms and, up to a maximum of six terms, for those who wish additional time to complete their Master’s thesis. All other students will be required to complete transitional coursework in the first year to adequately prepare for the final thesis year, and will complete degree requirements in six terms.
• Program type
  o Master’s
  o Professional

• Registration option(s)
  o Full-time

• Study option(s)
  o Thesis

Admission requirements

• Minimum requirements
  o A four-year, honours pre-professional undergraduate Architecture degree or professional Bachelor of Architecture degree with a minimum overall average of 75%.
  o Applicants being considered for admission to the Master of Architecture who have not completed three or more years of post-secondary work at a Canadian institution, or at an institution at which English was the language of instruction may be required to verify English Proficiency which may include a written exercise or interview as instructed by the School of Architecture. Details will be communicated when required after initial assessment of applications is complete. This is an additional departmental requirement and not a substitute for the English Language Proficiency Certification.

• Application materials
  o Portfolio
    ▪ Portfolio of design work – uploaded directly to applicant Quest account.
  o Résumé/curriculum vitae
  o Supplementary information form
    ▪ Including a statement of the students proposed research interest.
  o Transcript(s)
    ▪ From each post-secondary institution attended (past or current) showing all courses and marks, along with the transcript legends/keys/grading scales uploaded using Quest. Degree certificates (if obtained) must be uploaded with the transcripts.

• References
  o Number of references: 2
  o Type of references: academic

• English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements
The Master of Architecture curriculum covers six key areas: Design; History; Theory; Building Technology; Media and Methods; Professional Practice.

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete the following courses:
  - **Year 1:**
    - ARCH 690 Design Studio
    - ARCH 673 The Science of the Building Envelope
    - ARCH 642 Modern Architecture
    - ARCH 6XX Open graduate elective
    - ARCH 691 Design Studio - Comprehensive Building Design
    - ARCH 662 Steel & Concrete: Design, Structure and Construction
    - ARCH 640 Contemporary Theory, Culture and Criticism
  - **Year 2:** Fall
    - ARCH 692 Thesis Research and Design Studio I
    - ARCH 610 Architectural Research and Analysis
    - ARCH 6XX Open graduate elective
  - **Year 2:** Winter
    - ARCH 693 Thesis Research and Design Studio II
    - ARCH 655 Architectural Professional Practice: Ethics, Business, Legal Issues, and Contract Administration
    - ARCH 6XX Open graduate elective
  - **Year 2:** Spring
    - ARCH 6XX Open graduate elective
  - Students are encouraged to use elective courses to explore areas of specialization in support of their thesis research. Up to 1 half (0.50) credit elective may be taken in other departments. 1 half (0.50) course may be an independent Reading Course.

- **Master’s Thesis in Design**
  - Students must undertake and complete a research and design thesis (in Year 2: Spring). The thesis is developed within ARCH 692 and ARCH 693 and completed within the spring term. The thesis is supervised by a faculty advisor, and supported by a committee of one to two additional faculty members. The thesis must be presented and defended successfully before an Examining Committee composed of a minimum of the student’s supervisor, one committee member and one reader as per the requirements listed in the Graduate Studies Academic Calendar.

[School of Architecture website](#)
• The University of Waterloo offers a master's program leading to the Master of Architecture (MArch) professional degree. This program is designed to prepare students for professional qualification as architects. The Master of Architecture program combines elements of a professional master's program and a research-oriented master's program. It offers preparation for entry into the profession of architecture (together with an extension of the knowledge base required of practicing professionals) to students with a pre-professional undergraduate degree in Architecture, such as a Bachelor of Architectural Studies. The program is designed to develop the skills and intellectual curiosity required for a leadership role in the profession and in society, and for entry into doctoral studies. The Master’s Thesis, the core academic component of the program, will develop research and analytical/interpretive skills, as well as design skills - i.e., the synthetic skills of architecture.

• Referees will be emailed to complete and submit the official University of Waterloo Graduate Studies Reference form.

• Applicants who have not completed three or more years of post-secondary work at a Canadian institution, or at an institution at which English was the language of instruction, will be required to provide certification of English language proficiency. Information about accepted examinations of English Language can be found on the English Language Proficiency page.

• Refer to the Discover Graduate Studies website for complete information on admission requirements and application process.

• The Master of Architecture degree requirements are as follows:
Accelerated Master's Program in Electrical and Computer Engineering
(open to University of Waterloo Bachelor of Applied Science students only)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The Faculty of Engineering offers an Accelerated Bachelor's-Master's Program to high achieving University of Waterloo undergraduate students who are interested in pursuing graduate studies. Students must apply for admission to the Accelerated program in their 3B term. If admitted to the Master of Applied Science (MASc) program, students will undertake graduate work during their 4A and 4B terms. The Bachelor's degree is awarded at the normal completion of the undergraduate program; graduate course credits (maximum of 2) are applied to the Master's program resulting in a reduction in the number of terms required to complete the MASc program.

Individual Faculty of Engineering Departments may set requirements higher than the minimum requirements for the Accelerated Program.

Electrical and Computer Engineering (ECE) Accelerated BASc-MASc Program requirements

The ECE Department will only consider applicants to this program if they meet the 80% overall average requirement. The MASc program requires completion of 5 graduate level courses (0.50 unit weight per course) plus a thesis and a graduate seminar. There is no project option in ECE. At least 2 of the courses must be from the list of approved core courses (updated by the Department annually) in one of the approved areas of specialization as specified in the student's letter of admission. The choice of courses must meet with the approval of the supervisor.

ECE supervisors have to be found for students before they are admitted to this program even though they may satisfy the academic requirements. Interested students are encouraged to talk to individual ECE faculty members and explore possibilities of supervision. Both the academic program and financial details should be worked out between the student and the supervisor. These arrangements must then be approved by the ECE Associate Chair for Graduate Studies.

Coursework

Students accepted to the BASc-MASc accelerated program can take, during their 4A or 4B terms or during their undergraduate work term, as extra to degree, an approved ECE graduate course which could count towards their MASc degree. This course will not count towards their BASc degree requirements and can only be taken with the approval of the graduate course instructor, their supervisor, and the ECE Associate Chair for Graduate Studies.
With approval of the supervisor and ECE Associate Chair for Graduate Studies, work done by students during their fourth-year work term(s) under the direction of the supervisor can be included in their MASc thesis provided this work was not used for an ECE 499 project. Note: if the work is done in industry, permission from the company for the work to be published will be necessary.

Department of Electrical and Computer Engineering website
Graduate Diploma (GDip) in Business and Entrepreneurship

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Diploma

- Registration option(s)
  - Part-time

- Study option(s)
  - Coursework

Admission requirements

- Minimum requirements
  - A four year undergraduate Honours degree or equivalent from a recognized university.
  - In the case of a three year undergraduate degree or equivalent from a recognized university, a minimum of four years of industry experience may be considered for admission into the program.
  - A minimum average of 75% in the last two years of study.

- Application materials
  - Résumé
  - Transcript(s)

- English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements
• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  o Students are required to successfully complete any 6 courses from the BE course series for the GDip. BET 600 and 700 level courses are also eligible to be counted towards the 6 course GDip requirement, though these courses are restricted to students enrolled in the MBET program.
  o Students who complete 3 BE courses as part of another graduate qualification may apply to receive a Graduate Certificate of Completion from the Conrad Centre. Alternatively, they may apply for admission to the GDip program, successfully complete an additional 3 courses, and be awarded the GDip. A student may receive the Certificate of Completion, or the GDip, but not both. Similarly, BET courses can be counted towards only one graduate certification, diploma or degree.

Conrad Business, Entrepreneurship, and Technology Centre website
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- The Graduate Diploma (GDip) in Business and Entrepreneurship is an industry-oriented Graduate-level part-time program established to address societal needs by improving the analytical and management capabilities of industry professionals.

- Admission requirements for the GDip are:

- Provide proof of proficiency in English (if applicable); accepted examinations and required minimum scores for graduate studies are listed on the English Language Proficiency page.
Master of Business, Entrepreneurship and Technology (MBET)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall

- Delivery mode(s)
  - On-campus

- Program type
  - Master’s
  - Professional

- Registration option(s)
  - Full-time

- Study option(s)
  - Coursework

Admission requirements

- Minimum requirements
  - An Honours degree with a minimum of 75% or its equivalent.
  - Normally have at least one year of prior work experience obtained either through cooperative work terms as part of an undergraduate academic program or through post-graduate work experience.
  - As part of the admissions process, an interview is required. Applicants who are unable to come to campus for a personal interview will be interviewed by telephone.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
Type of references:
- at least 1 academic
- at least 1 professional

- English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

- Graduate Academic Integrity Module (Graduate AIM)

- Courses
  - Students must complete the following 9 graduate-level courses (0.50 unit weight):
    - BET 600 Applied Business Leadership Skills for Entrepreneurs
    - BET 601 Strategically Managing the Entrepreneurial Organization
    - BET 602 Marketing Strategies for New Technology-based Ventures
    - BET 603 Entrepreneurial Finance for the Technology-based Enterprise
    - BET 604 New Technology-based Venture Creation
    - BET 605 Essential Accounting for Entrepreneurs
    - BET 607 Managing Technological Innovation
    - BET 608 Entrepreneurial Application of Technology
    - BET 620 Social Entrepreneurship and Corporate Social Responsibility

- Graduate Studies Practicum
  - Students must complete a commercialization practicum.

Conrad Business, Entrepreneurship, and Technology Centre website
The Master of Business, Entrepreneurship, and Technology (MBET) is the degree that
distinguishes graduates from general business programs by emphasizing technological,
innovative and entrepreneurial energies that are the foundation of the University of Waterloo's
reputation.

To be admitted for graduate studies in the MBET program, a student must:

Provide certification of English language proficiency through one of the accepted examinations if
the candidate for admission has not completed three or more years of post-secondary work at a
Canadian institution, or at an institution at which English was the language of instruction, or has
not been employed for similar period of time in a position in which English was the language of
business. For those taking the Test of English as a Foreign Language (TOEFL), an Internet Based
Toefl (IBT) score of 90, with 25 writing and 25 speaking is required. A comparable score is
required for those taking an alternate test as prescribed in the Graduate Studies Calendar.

MBET draws on the technological, innovative and entrepreneurial energies that are the
foundation of the University of Waterloo's reputation to distinguish itself from other graduate
business programs. Degree Requirements for the MBET program are:
Memorandum

Date: January 25, 2016

To: Bruce Hellinga, Associate Dean, Graduate Studies, Faculty of Engineering

From: Sherman Shen, Associate Chair, Graduate Studies, Electrical and Computer Engineering

Subject: ECE Graduate Calendar Revisions

As part of the GSO Graduate Calendar update initiative, the Department of Electrical and Computer Engineering has reviewed the revisions proposed by the Graduate Studies Office and subsequent department amendments. These changes were approved at a regular meeting of the Electrical and Computer Engineering Department on Thursday, January 21, 2016.

Regards,

Sherman Shen
Associate Chair, Graduate Studies
Electrical & Computer Engineering
EIT Building, Room 4155
University of Waterloo

Tel: 519-888-4567 ext. 32691
Fax: 519-746-3077
Email: sshen@uwaterloo.ca

/SL
Certificate of Completion in Electric Power Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The Department of Electrical and Computer Engineering offers Certificates of Completion awarded to participants upon successful completion of a course from the list of courses offered within the Master of Engineering (MEng) in Electrical and Computer Engineering - Electric Power Engineering program. Courses are offered on a cost recovery basis, and are offered online.

Students admitted to the Electric Power Engineering Non-Degree program who wish to apply to the Graduate Diploma (GDip) in Electric Power Engineering or MEng in Electrical and Computer Engineering - Electric Power Engineering program, must apply directly to the desired program. Students are not permitted to transfer from Non-Degree to either the MEng or GDip programs.

Courses taken during Non-Degree study cannot be used to meet either the diploma or degree program requirements.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - Online

- Program type
  - Certificate

- Registration option(s)
  - Part-time

- Study option(s)
  - Coursework

Admission requirements

- Minimum requirements
Admission requirements for the Certificate of Completion include an engineering degree or equivalent from a recognized university.

- **Application materials**
  - Supplementary information form
  - Transcript(s)

- **References**
  - Number of references: 2
  - Type of references: industry

- **English Language Proficiency Certification (ELPC) (if applicable)**

**Certificate requirements**

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Candidates are awarded a Certificate of Completion after successful completion of 1 course taken from a select group of courses offered in Electric Power Engineering:
    - ECE 6601PD Power System Components and Modeling
    - ECE 6602PD Power System Management and Electricity Markets
    - ECE 6603PD Electromagnetic Compatibility and Power Quality
    - ECE 6604PD Distributed Generation
    - ECE 6605PD Power System Protection
    - ECE 6606PD Distribution System Engineering
    - ECE 6607PD Operation of Restructured Power Systems
    - ECE 6608PD Dielectrics and Electrical Insulation
    - ECE 6609PD High Voltage Engineering Applications
    - ECE 6610PD Power Electronics Converters: Design and Applications
    - ECE 6611PD Electric Machines and Motor Drives
    - ECE 6612PD FACTS: Models, Controls and Applications
    - ECE 6613PD Power System Analysis
    - ECE 6614PD Industrial Utilization of Electrical Energy
    - ECE 6615PD Design and Application of DC/DC Converters
    - ECE 6616PD Electric Safety and Grounding System Design
    - ECE 6617PD Asset Management and Risk Assessment of Power Systems
    - ECE 6618PD Medium and HV Power Cables

[Department of Electrical and Computer Engineering website]
This option is designed for those industry personnel who are seeking to update their knowledge on any specific subject in the field.

Applicants must apply online through the regular application process.

Visit the MEng Electric Power (online) webpage for detailed information about the program.
Doctor of Philosophy (PhD) in Electrical and Computer Engineering - Nanotechnology

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- **Admit term(s)**
  - Fall
  - Winter
  - Spring

- **Delivery mode(s)**
  - On-campus

- **Length of program**
  - The minimum period of registration for the Doctoral degree is four terms after a Master’s degree or equivalent and six terms after an Honours Bachelor’s degree or equivalent. The maximum time limit is twelve terms after a Master’s degree or equivalent and eighteen terms after an Honours Bachelor's degree or equivalent. Extensions beyond twelve terms must be approved by the Faculty Graduate Studies Office.

- **Program type**
  - Doctoral
  - Collaborative
  - Research

- **Registration option(s)**
  - Full-time
  - Part-time

- **Study option(s)**
  - Thesis

Admission requirements

- Minimum requirements
Admission to the program is based upon the student’s academic record and evidence of ability to pursue independent research.

Normally a Master of Applied Science (MASc) degree from the University of Waterloo or an equivalent degree in engineering, applied science or mathematics from a university of recognized standing with an 83% average.

At the time of admission, each student must have a faculty supervisor who has endorsed the recommendation for admission.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: at least 2 academic.

- English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

- Graduate Academic Integrity Module (Graduate AIM)

- Courses
  - Students who are admitted with an appropriate master’s degree must complete a total of at least 4 courses (0.50 unit weight) including 2 required core courses and 2 elective courses from the list of technical electives, the choice of courses must meet with the approval of the supervisor.
  - Students who are admitted with an appropriate honours bachelor’s degree or who transfer directly from a master’s program to the PhD program must complete a total of at least 7 courses (0.50 unit weight) including 2 required core courses and 5 elective courses from the list of technical electives.
  - Students who have completed their Bachelor of Applied Science (BASc) degree in Nanotechnology Engineering or Master’s degree in Nanotechnology at the University of Waterloo are not obliged to take the 2 core courses as part of the minimum course requirement. Instead, they can choose all graduate courses from the list of technical electives to meet the total course credit requirement.
  - Nanotechnology core courses:
    - NANO 701 Fundamentals of Nanotechnology (students must complete any 2 of the 0.25 unit weight modules)
    - NANO 702 Nanotechnology Tools (students must complete any 2 of the 0.25 unit weight modules)
Technical elective courses:

(a) Micro/nano Instruments and Devices
- BIOL 642 Current topics in Biotechnology
- CHEM 750T17 Surface Science and Nanotechnology
- CHEM 750TX Nanostructured Materials and Analysis
- CHEM 724 Chemical Instrumentation
- ME 770 Topics in Heat and Fluid Flow: Micro- and Nano- fluidics
- ME 738 Topics in Materials Science: Materials for NEMS and MEMS
- ME 780 Topics in Mechatronics: MEMS Design and Analysis
- SYDE 682 Advanced MEMS Physics, Design and Fabrication
- SYDE 750 Modeling, Simulation and Design of MEMS

(b) Nanoelectronics Design and Fabrication
- CHEM 750T11 Bioelectronics
- CHEM 750T19 Carbon Nanotube Electronics
- ECE 631 Microelectronic Processing Technology
- ECE 632 Photovoltaic Energy Conversion
- ECE 633 Nanoelectronics
- ECE 634 Organic Electronics
- ECE 635 Fabrication in the nanoscale: principles, technology and applications
- ECE 636 Analog MOS and Bipolar Integrated Circuits
- ECE 637 Design of VLSI MOS Integrated Circuits
- ECE 639 Characteristics & Applications of Amorphous Silicon
- ECE 672 Optoelectronic Devices
- ECE 676 Quantum Info Processing Devices
- ECE 677 Quantum Electronics & Photonics
- ECE 730T17 Topics in Solid State Devices: Physics and Modeling of Semiconductor Devices
- ECE 730T19 Topics in Solid State Devices: Magnetism and Spintronics
- ECE 730T20 Topics in Solid State Devices: Physics of Nanodevices
- ECE 770T13 Topics in Antenna and Microwave Theory: Quantum Information Devices
- ME 595 Introduction to MEMS Fabrication
- ME 596 Topics in Nanotechnology: Introduction to Fabrication & Characterization of Nano-structures
- PHYS 713 Molecular Physics
- PHYS 731 Solid State Physics
- PHYS 747 Optical Electronics
(c) Nano-biosystems

- BIOL 608 Advanced Molecular Genetics
- BIOL 614 Bioinformatics Tools and Techniques
- BIOL 629 Cell Growth and Differentiation
- BIOL 642 Current Topics in Biotechnology
- BIOL 670 Photobiology
- BIOL 678 Current topics in Neurophysiology
- CHE 562 Advanced Bioprocess Engineering
- CHE 660 Principles of Biochemical Engineering
- CHE 661 Advances in Biochemical Engineering
- CHE 760 Special Topics in Biochemical Engineering
- CHE 765 Research Topics in Biochemical Engineering
- CHEM 730 Proteins and Nucleic Acids
- CHEM 731T02 Physical Biochemistry
- CHEM 737 Enzymes
- PHYS 751 Cellular Biophysics
- PHYS 752 Molecular Biophysics

(d) Nanomaterials

- CHE 541 Introduction to Polymer Science and Properties
- CHE 542 Polymerization and Polymer Properties
- CHE 612 Interfacial Phenomena
- CHE 622 Statistics in Engineering
- CHE 640 Principles of Polymer Science (Cross-listed with CHEM 770)
- CHE 641 Physical Properties of Polymers (Cross-listed with CHEM 771)
- CHE 740 Special Topics in Polymer Science and Engineering
- CHE 750 Special Topics in Materials Science: Thin Film Fabrications & Mechanical Properties
- CHE 755 Research Topics in Electrochemical Engineering, Interfacial Engineering & Material Science
- CHE 745 Research Topics in Polymer Science and Engineering
- CHEM 710T12 Structure and Function of Supramolecular Materials
- CHEM 710T15 Advanced Solid State Chemistry: Ion, Electron and Molecular Transport
- CHEM 710TXX Nanostructured Materials and Integrative Chemistry
- CHEM 713 Chemistry of Inorganic Solid State Materials
- CHEM 750T17 Surface Science and Nanotechnology
- ME 632 Experimental Methods in Materials Engineering
- ME 738 Topics in Materials Science: Materials for NEMS and MEMS
- ME 738 Topics in Materials Science: Nanostructured and Amorphous Materials
• ME 738T8 Topics in Materials Science: Introductory and Advanced Nanomechanics
• PHYS 701 Quantum Mechanics
• PHYS 704 Statistical Physics
• PHYS 706 Electromagnetic Theory
• PHYS 773 Special Topics

o The faculty supervisor will consider the level and adequacy of each student’s preparation in drawing up the candidate's program. It is expected that candidates will maintain a 78% minimum cumulative average in their course work. To obtain credit, an individual course must be passed with at least 75%.

• PhD Comprehensive Examination I and PhD Comprehensive Examination II
  o The background comprehensive examination and the comprehensive proposal examination are conducted by the Department for each candidate.
  o The first exam, the Background Comprehensive Examination, will be held before the end of the third term (fourth term if from an incomplete MASc). The main objective of this examination is to satisfy the Department that the candidate has a broad knowledge of their field and a thorough technical background to pursue their research; the candidate will be questioned on their background preparation.
  o The second exam, the Comprehensive Proposal Examination, will be held no later than the student’s sixth term and only after the Background Comprehensive Examination has been successfully completed. The main objective of this examination is to examine and approve the thesis proposal.
  o The result of these examinations is the identification of an Advisory Committee which has examined and approved the candidate’s background and thesis proposal and is willing to assist the supervisor with the subsequent research program. The validity of the comprehensive examination expires after three years.
  o Students who do not complete either Comprehensive Exam by the stated deadline, or fail either exam in its entirety, will be required to withdraw from the program.

• Nanotechnology Seminar
  o This seminar is a forum for student presentation of research results or proposals. The range of topics that will be addressed in the seminar crosses all areas of research in the collaborative program. Each student is required to present at least 1 Nanotechnology research seminar over the course of the degree. The Nanotechnology Seminar may simultaneously count towards the PhD Seminar requirement of the ECE Department.

• PhD Seminar
  o The aim of the PhD seminar is to allow students to gain experience in preparing and presenting their work. The seminar is to be held no later than the end of the third year after the initial registration in the program. The seminar must be attended by the
student’s supervisor and their Advisory Committee. Other Faculty members and PhD and MASc students may also be in attendance. Since this is not intended to be an examination, the seminar presentation and the feedback communication, would be regarded as satisfying the seminar credit requirements.

- Students who do not complete the PhD Seminar by the stated deadline will be required to withdraw from the program.

- PhD Thesis
  - The primary objective of the program is the accomplishment of independent and original research work and reporting thereon in a research thesis.
  - The requirements for the PhD degree are completed when the student successfully defends their thesis before an Examination Committee. This committee should consist of the supervisor, three other members of the University (at least one of whom should be from outside the Department) and an external examiner. Faculty from other Departments who hold cross appointments in the Department are counted as departmental members in defining examining committees.

Department of Electrical and Computer Engineering website
Waterloo Institute for Nanotechnology website
The University of Waterloo offers the first Master of Applied Science (MASc) and Doctor of Philosophy (PhD) programs in Nanotechnology of its kind in Canada. The interdisciplinary research programs, jointly offered by three departments in the Faculty of Science and four in the Faculty of Engineering, provide students with a stimulating educational environment that spans from basic research through to application. The goal of the collaborative programs is to allow students to gain perspectives on nanotechnology from a wide community of scholars within and outside their disciplines in both course and thesis work.

The MASc degree collaborative program provides a strong foundation in the emerging areas of nano-science or nano-engineering in preparation for the workforce or for further graduate study and research leading to a doctoral degree. Four key areas of research strengths have been identified: nanomaterials, nano-electronics design and fabrication, nano-instruments and devices, and nano-biosystems. The objective of the PhD program is to prepare students for careers in academia, industrial R & D and government research labs. Students from Science and Engineering will work side-by-side in world class laboratory facilities namely, the Giga-to-Nano Electronics Lab (G2N), Waterloo Advanced Technology Lab (WatLAB) and the new 225,000 gross sq. ft. Nano-Quantum Center expected to be completed in early 2011.

There are nearly 50 faculty members involved in nanotechnology research at the university with many who are internationally renowned leaders in their fields. Among them are seven Canada Research Chairs and two NSERC Industrial Research Chairs.

Admission requirements are the same as home department programs. The home department in which the applicant intends to pursue graduate study must approve the application. Interested students should apply directly to one of the following departments via the regular university application process:

- Biology
- Chemical Engineering
- Chemistry
- Electrical and Computer Engineering
- Mechanical and Mechatronics Engineering
- Physics and Astronomy
- Systems Design Engineering

Financial Support

All graduate students engaged in MASc and PhD studies at the University of Waterloo receive financial support. In addition, students admitted into the collaborative Nanotechnology graduate program are also eligible to apply for Fellowships in Nanotechnology, valued at CDN
$10,000 each, through the Waterloo Institute for Nanotechnology (WIN). Fellowship funding is on top of the research support from the supervising Faculty Member and can be held simultaneously with other graduate awards (subject to the requirements of other scholarships/awards). Additional information is available at the Waterloo Institute for Nanotechnology website

- **Admission Requirements**

  Admission requirements are the same as those for the PhD in Electrical and Computer Engineering.

- **Note:** It is possible that some students may need to take more courses than are prescribed by the home department in order to meet the specific course requirements of the collaborative program.

- Generally, students are required to take two core courses and complete the Nanotechnology Seminar. All core courses have written examinations, as do all ECE graduate courses.

- **Technical Electives**
  Approved technical elective courses (pdf)
Doctor of Philosophy (PhD) in Electrical and Computer Engineering - Quantum Information

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Length of program
  - The minimum period of registration for the Doctoral degree is four terms after a Master’s degree or equivalent and six terms after an Honours Bachelor’s degree or equivalent. The maximum time limit is twelve terms after a Master’s degree or equivalent and eighteen terms after an Honours Bachelor’s degree or equivalent. Extensions beyond twelve terms must be approved by the Faculty Graduate Studies Office.

- Program type
  - Doctoral
  - Collaborative
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
Admission to the program is based upon the student’s academic record and evidence of ability to pursue independent research.

Normally a Master of Applied Science (MASc) degree from the University of Waterloo or an equivalent degree in engineering, applied science or mathematics from a university of recognized standing with an 83% average.

At the time of admission, each student must have a faculty supervisor who has endorsed the recommendation for admission.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: at least 2 academic.

- English Language Proficiency Certification (ELPC) (if applicable)

**Degree requirements**

- Graduate Academic Integrity Module (Graduate AIM)

- Courses
  - Students admitted to the program with a non-Quantum Information MASc degree must complete a total of at least 5 half credit courses (0.50 unit weight):
    - 3 core courses:
      - QIC 710 Quantum Information Processing
      - QIC 750/ECE 676 Implementation of Quantum Information Processing
      - QIC 885/ECE 677 Quantum Electronics & Photonics
    - 1 additional QIC course:
      - QIC 820 Theory of Quantum Information
      - QIC 823 Quantum Algorithms
      - QIC 845 Open Quantum Systems (AMATH 876)
      - QIC 880 Nanoelectronics for Quantum Information Processing
      - QIC 890 Topics in Quantum Information
      - QIC 891 Topics in Quantum Information
      - QIC 895 Topics in Quantum Information
    - 1 of the following electives:
      - ECE 633 Nanoelectronics
      - ECE 635 Fabrication of Nanoscale: Techniques & Applications
      - ECE 671 Microwave and RF Engineering
      - ECE 730 Special Topics in Solid State Devices (19 Magnetism and Spintronics, 20 Physics of Nanodevices)
Students admitted to the program with a MASc in Electrical and Computer Engineering - Quantum Information degree from the University of Waterloo must complete a total of at least 4 half credit courses (0.50 unit weight).

- At least 2 of the required 4 half credit courses must be taken from the approved ECE list below:
  - ECE 633 Nanoelectronics
  - ECE 635 Fabrication of Nanoscale: Techniques & Applications
  - ECE 671 Microwave and RF Engineering
  - ECE 730 Special Topics in Solid State Devices (19 Magnetism and Spintronics, 20 Physics of Nanodevices)

- At least 1 of the required 4 half credit courses must be a QIC course (note: core courses QIC 710, QIC 750, and QIC 885 will have been met in the previous MASc in Electrical and Computer Engineering - Quantum Information program):
  - QIC 820 Theory of Quantum Information
  - QIC 823 Quantum Algorithms
  - QIC 845 Open Quantum Systems (AMATH 876)
  - QIC 880 Nanoelectronics for Quantum Information Processing
  - QIC 890 Topics in Quantum Information
  - QIC 891 Topics in Quantum Information
  - QIC 895 Topics in Quantum Information

- The 4th course may be selected from either of the above lists.

Students admitted to the program with an incomplete Master’s or Honours Bachelor’s degree must complete a total of at least 8 half credit courses (0.50 unit weight):

- 3 core courses:
  - QIC 710 Quantum Information Processing
  - QIC 750/ECE 676 Implementation of Quantum Information Processing
  - QIC 885/ECE 677 Quantum Electronics & Photonics

- 1 additional QIC course:
  - QIC 820 Theory of Quantum Information
  - QIC 823 Quantum Algorithms
  - QIC 845 Open Quantum Systems (AMATH 876)
  - QIC 880 Nanoelectronics for Quantum Information Processing
  - QIC 890 Topics in Quantum Information
  - QIC 891 Topics in Quantum Information
  - QIC 895 Topics in Quantum Information

- 1 of the following electives:
  - ECE 612 - Information Theory
  - ECE 604 - Stochastic Process
  - ECE 672 - Optoelectronics
  - ECE 720-T2 - Cryptographic Computation

- 3 of the following electives:
  - ECE 633 Nanoelectronics
  - ECE 635 Fabrication of Nanoscale: Techniques & Applications
• ECE 671 Microwave and RF Engineering
• ECE 730 Special Topics in Solid State Devices (19 Magnetism and Spintronics, 20 Physics of Nanodevices)
  o The choice of courses must meet with the approval of the supervisor. The faculty supervisor will consider the level and adequacy of each student’s preparation in drawing up the candidate’s program. It is expected that candidates will maintain a 78% minimum cumulative average in their course work. To obtain credit, an individual course must be passed with at least 75%.

• PhD Comprehensive Examination I and PhD Comprehensive Examination II
  o The background comprehensive examination and the comprehensive proposal examination are conducted by the Department for each candidate.
  o The first exam, the Background Comprehensive Examination, will be held before the end of the third term (fourth term if from an incomplete MASc). The main objective of this examination is to satisfy the Department that the candidate has a broad knowledge of their field and a thorough technical background to pursue their research; the candidate will be questioned on their background preparation.
  o The second exam, the Comprehensive Proposal Examination, will be held no later than the student’s sixth term and only after the Background Comprehensive Examination has been successfully completed. The main objective of this examination is to examine and approve the thesis proposal.
  o The result of these examinations is the identification of an Advisory Committee which has examined and approved the candidate’s background and thesis proposal and is willing to assist the supervisor with the subsequent research program. The validity of the comprehensive examination expires after three years.
  o Students who do not complete either Comprehensive Exam by the stated deadline, or fail either exam in its entirety, will be required to withdraw from the program.

• PhD Quantum Information Seminar (scheduled with the Institute for Quantum Computing)
  o Students must fulfill a PhD Quantum Information Seminar milestone consisting of 1 IQC seminar, the Quantum Information seminar may simultaneously count towards the PhD Seminar requirement of the ECE Department.

• PhD Seminar (scheduled with the ECE Department)
  o The aim of the PhD Seminar is to allow students to gain experience in preparing and presenting their work. The seminar is to be held no later than the end of the third year after the initial registration in the program. The seminar must be attended by the student’s supervisor and their Advisory Committee. Other Faculty members and PhD and MASc students may also be in attendance. Since this is not intended to be an examination, the seminar presentation and the feedback communication, would be regarded as satisfying the seminar credit requirements.
- Students who do not complete the PhD Seminar by the stated deadline will be required to withdraw from the program.

- PhD Thesis
  - Students must complete an original research thesis in Quantum Information and an oral defense.
  - The primary objective of the program is the accomplishment of independent and original research work and reporting thereon in a research thesis.
  - The requirements for the PhD degree are completed when the student successfully defends their thesis before an Examination Committee. This committee should consist of the supervisor, three other members of the University (at least one of whom should be from outside the Department) and an external examiner. Faculty from other Departments who hold cross appointments in the Department are counted as departmental members in defining examining committees.
  - A list of approved Quantum Information thesis supervisors is available on the [Department of Electrical and Computer Engineering website](https://www.example.com).

[Department of Electrical and Computer Engineering website](https://www.example.com)
[Institute for Quantum Computing website](https://www.example.com)
The University of Waterloo, home of the Institute for Quantum Computing, offers graduate students unique opportunities to learn about and engage in world-leading research in quantum information through a wide range of advanced research projects and advanced courses on the foundations, applications and implementation of quantum information processing.

In particular, the University of Waterloo offers a unique interdisciplinary graduate program in Quantum Information that leads to Master of Mathematics (MMath), Master of Science (MSc), Master of Applied Science (MASc), and Doctor of Philosophy (PhD) degrees. This program is a collaboration between the Institute for Quantum Computing and:

- The Departments of Applied Mathematics, Combinatorics and Optimization, and the David R. Cheriton School of Computer Science in the Faculty of Mathematics
- The Departments of Chemistry and Physics and Astronomy in the Faculty of Science
- The Department of Electrical and Computer Engineering in the Faculty of Engineering

These academic units are referred to hereinafter as the home units.

MMath, MSc, and MASc students will receive both strong and broad foundations in quantum information science, coupled with knowledge and expertise obtained within their home programs. This will prepare them for the workforce and/or further graduate studies and research leading towards a PhD degree.

PhD students will be especially well-prepared for careers as scholars and researchers, with advanced expertise in quantum information science, together with the focus of their home programs. This new program is designed to provide students with knowledge of quantum information, including both theory and its implementations, advanced expertise in quantum information science and in home program disciplines, as well as training in research.

Admission requirements are the same as those of the home programs. The home unit in which an applicant intends to pursue graduate study must approve the application. Interested students should apply directly to one of the following units via the regular university application process:

- Department of Applied Mathematics
- Department of Chemistry
- Department of Combinatorics and Optimization
- David R. Cheriton School of Computer Science
- Department of Electrical and Computer Engineering
- Department of Physics and Astronomy
Information specific to the Department of Electrical and Computer Engineering (ECE) is given below.

- **Admission Requirements**

  Admission requirements are the same as those for the PhD in Electrical and Computer Engineering.

- **Students must fulfill the general requirements for the Quantum Information Collaborative Program, as well as the minimum degree requirements of their home unit. It is possible that some students may need to take more courses than are prescribed by the home program in order to meet the specific course requirements of the quantum information program.**

- **From Electrical and Computer Engineering MASc with Quantum Information Specialization:**

  - PhD Comprehensive Examination Milestone (to be completed by the end of the 4th term of registration)

  - A list of Quantum Information courses that are offered each term can be found on the Institute for Quantum Computing website.

For more information about the program, please contact the Department of Electrical and Computer Engineering Graduate Studies Office.
Doctor of Philosophy (PhD) in Electrical and Computer Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Antennas, Microwaves and Wave Optics
- Circuits and Systems Including Computer - Aided Design
- Communications and Information Systems
- Computer Hardware
- Computer Software
- Nanotechnology
- Pattern Analysis and Machine Intelligence (PAMI)
- Power and Energy Systems
- Quantum Information
- Silicon Devices and Integrated Circuits
- Systems and Control
- Very Large Scale Integration (VLSI)
- Wireless Communication

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Length of program
  - The minimum period of registration for the Doctoral degree is four terms after a Master's degree or equivalent and six terms after an Honours Bachelor's degree or equivalent. The maximum time limit is twelve terms after a Master’s degree or equivalent and eighteen terms after an Honours Bachelor's degree or equivalent. Extensions beyond twelve terms must be approved by the Faculty Graduate Studies Office.

- Program type
• Doctoral
  • Research

• Registration option(s)
  • Full-time
  • Part-time

• Study option(s)
  • Thesis

Admission requirements

• Minimum requirements
  • Admission to the program is based upon the student's academic record and evidence of ability to pursue independent research.
  • Normally a Master of Applied Science (MASc) degree from the University of Waterloo or an equivalent degree in engineering, applied science, or mathematics from a university of recognized standing with an 83% average.
  • At the time of admission, each student must have a faculty supervisor who has endorsed the recommendation for admission.

• Application materials
  • Résumé
  • Supplementary information form
  • Transcript(s)

• References
  • Number of references: 3
  • Type of references: at least 2 academic.

• English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  • The coursework associated with the program is intended to provide a foundation for advanced learning in the chosen field of research. A minimum of 4 courses (0.50 unit weight per course) is required for a PhD student holding a MASc degree or equivalent (7 0.50 unit weight courses from a Bachelor program). At least 2 of the courses must be from the list of approved core courses (updated by the Department annually) in one of the approved areas of specialization as specified in the student’s letter of admission,
unless this course requirement has already been achieved during a University of Waterloo Electrical and Computer Engineering MASc program. The remaining 2 courses may be taken from outside of the Department but must be from the faculties of Engineering, Math, and/or Science (unless otherwise approved). The choice of courses must meet with the approval of the supervisor. The faculty supervisor will consider the level and adequacy of each student's preparation in drawing up the candidate's program. It is expected that candidates will maintain a 78% minimum cumulative average in their course work. To obtain credit, an individual course must be passed with at least 75%.

- Core courses:
  - Antennas, Microwaves, and Wave Optics
    - ECE 642 Radio Frequency Integrated Circuit Design
    - ECE 671 Microwave and RF Engineering
    - ECE 672 Optoelectronic Devices
    - ECE 675 Radiation and Propagation of Electromagnetic Fields
    - ECE 676 (QIC 750) Quantum Information Processing Devices
    - ECE 677 (QIC 885) Quantum Electronics and Photonics
  - Circuits and Systems
    - ECE 636 Advanced Analog Integrated Circuits
    - ECE 637 Digital Integrated Circuits
    - ECE 671 Microwave and RF Engineering
  - Communications and Information Systems
    - ECE 603 Statistical Signal Processing
    - ECE 604 Stochastic Processes
    - ECE 610 Broadband Communication Networks
    - ECE 611 Digital Communications
    - ECE 612 Information Theory
  - Computer Hardware
    - ECE 606 Algorithm Design
    - ECE 621 Computer Organization
    - ECE 627 Register-transfer-level Digital Systems
    - ECE 637 Digital Integrated Circuits
  - Computer Software
    - ECE 606 Algorithm Design and Analysis
    - ECE 650 Methods and Tools for Software Engineering
    - ECE 653 Software Testing, Quality Assurance and Maintenance
    - ECE 654 Software Reliability Engineering
    - ECE 656 Database Systems
  - Nanotechnology
    - ECE 630 Physics and Models of Semiconductor Devices
    - ECE 633 Nanoelectronics
• ECE 634 Organic Electronics
• ECE 635 Fabrication in the Nanoscale: Principles, Technology and Applications
• ECE 672 Optoelectronic Devices

- **PAMI - Pattern Analysis and Machine Intelligence**
  • ECE 606 Algorithm Design and Analysis
  • ECE 613 Image Processing and Visual Communication
  • ECE 657 Tools of Intelligent Systems Design
  • ECE 657A Data and Knowledge Modelling and Analysis
  • ECE 659 Intelligent Sensors and Sensor Networks

- **Power and Energy Systems**
  • ECE 662 Power Systems Analysis and Control
  • ECE 663 Energy Processing
  • ECE 665 High Voltage Engineering Applications
  • ECE 666 Power Systems Operation
  • ECE 668 Distribution System Engineering

- **Quantum Information**
  • QIC 710 Quantum Information Processing
  • ECE 677(QIC 885) Quantum Electronics and Photonics
  • ECE 676 (QIC750) Quantum Information Processing Devices

- **Silicon Devices and Integrated Circuits**
  • ECE 630 Physics and Models of Semiconductor Devices
  • ECE 631 Microelectronic Processing Technology
  • ECE 634 Organic Electronics
  • ECE 636 Advanced Analog Integrated Circuits
  • ECE 671 Microwave and RF Engineering
  • ECE 672 Optoelectronic Devices

- **Systems and Controls**
  • ECE 602 (CO 602) Introduction to Optimization
  • ECE 604 (STAT 901) Stochastic Processes
  • ECE 682 Multivariable Control Systems
  • ECE 686 Filtering and Control of Stochastic Linear Systems
  • ECE 688 Nonlinear Systems

- **VLSI - Very Large Scale Integration**
  • ECE 636 Advanced Analog Integrated Circuits
  • ECE 637 Digital Integrated Circuits
  • ECE 671 Microwave and RF Engineering

- **Wireless Communication**
  • ECE 603 Statistical Signal Processing
  • ECE 604 Stochastic Processes
• PhD Comprehensive Examination I and PhD Comprehensive Examination II
  o The background comprehensive examination and the comprehensive proposal examination are conducted by the Department for each candidate.
  o The first exam, the Background Comprehensive Examination, will be held before the end of the third term (fourth term if from an incomplete MASc). The main objective of this examination is to satisfy the Department that the candidate has a broad knowledge of their field and a thorough technical background to pursue their research; the candidate will be questioned on their background preparation.
  o The second exam, the Comprehensive Proposal Examination, will be held no later than the student’s sixth term and only after the Background Comprehensive Examination has been successfully completed. The main objective of this examination is to examine and approve the thesis proposal.
  o The result of these examinations is the identification of an Advisory Committee which has examined and approved the candidate’s background and thesis proposal and is willing to assist the supervisor with the subsequent research program. The validity of the comprehensive examination expires after three years.
  o Students who do not complete either Comprehensive Examination by the stated deadline, or fail either exam in its entirety, will be required to withdraw from the program.

• PhD Seminar
  o The aim of the seminar is to allow students to gain experience in preparing and presenting their work. The seminar is to be held no later than the end of the third year (ninth term) after the initial registration in the program. The seminar must be attended by the student’s supervisor and their Advisory Committee. Other Faculty members and PhD and MASc students may also be in attendance. Since this is not intended to be an examination, the seminar presentation and the feedback communication, would be regarded as satisfying the seminar credit requirements.
  o Students who do not complete the PhD Seminar by the stated deadline will be required to withdraw from the program.

• PhD Thesis
  o The primary objective of the program is the accomplishment of independent and original research work and reporting thereon in a research thesis.
  o The requirements for the PhD degree are completed when the student successfully defends their thesis before an Examination Committee. This committee should consist of the supervisor, three other members of the University (at least one of whom should
be from outside the Department) and an external examiner. Faculty from other Departments who hold cross appointments in the Department are counted as departmental members in defining examining committees.
• Normally, admission is made to a two-year PhD program from the Master's degree. Once candidates are formally registered they must maintain active registration continuously until the thesis is submitted.

• The principal admission criteria are:

• Excellence of background preparation and academic achievement in prior degrees and the possession of a relevant Master's degree.

• Proof of competency in English (if applicable). A score of at least 550 is required in the Test of English as a Foreign Language (TOEFL). A score of at least 213 is required on the computer version of the TOEFL. See the English Language Proficiency page for other acceptable tests of English.

• All applicants must submit a Supplementary Information Form available through the on-line application process.

• Refer to the Graduate Studies Office website for additional information concerning application and admission requirements.

• The subsidiary requirements are completion of a suitable coursework program, passing a comprehensive examination and receiving a satisfactory review by an advisory committee.
Graduate Diploma (GDip) in Computer Networking and Security

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Delivery mode(s)
  - On-campus

- Program type
  - Diploma

- Study option(s)
  - Coursework

Admission requirements

The GDip in Computer Networking and Security is earned in conjunction with the Master of Engineering (MEng) in Electrical and Computer Engineering program.

Diploma requirements

- Courses
  - Students will be exposed to the fundamental, advanced, and practical aspects of computer networks, security, and distributed computing systems. They will gain knowledge in the field of local and wide area networks - both wired and wireless. Students will learn designing network based systems for parallel and distributed processing; and the security aspects of communication and distributed system applications.
  - To receive the GDip in Computer Networking and Security, students must successfully complete 3 compulsory courses and 2 elective courses:
    - Compulsory courses:
      - ECE 610 Broadband Communication Networks
      - ECE 628 Computer Network Security
      - ECE 655 Protocols, Software, Issues in Mobile Systems
    - Elective courses (choose 2 from the following list):
      - ECE 606 Algorithm Design and Analysis
      - ECE 651 Foundations of Software Engineering
      - ECE 653 Software Testing, Quality Assurance and Maintenance
      - ECE 654 Software Reliability Engineering
- ECE 656 Database Systems
- ECE 657 Tools of Intelligent Systems Design
- ECE 658 Component Based Software
  - Note: Electrical and Computer Engineering MEng requirements allow for only 3 courses to be taken outside the Department.

Department of Electrical and Computer Engineering website
The Department of Electrical and Computer Engineering (ECE) offers four University-level diplomas, as outlined below.

The objectives of this program are:

- To train engineers with a more specialized technical background and specific focus that is recognized by the award of a Graduate Diploma.
- To offer a course-work based professional development graduate program for practicing engineers to be formally trained in the very topical areas of computer networking and security, software engineering, sustainable energy and management sciences.
- To provide new immigrants, foreign-trained engineers a degree program that facilitates entry to the Canadian workforce in important technical areas of significant national interest.
- To provide newly graduated engineers an opportunity to pursue graduate education in the very topical areas of computer networking and security, software engineering, sustainable energy and management sciences.

For additional program information please visit the Master of Engineering (MEng) webpage or contact the MEng Coordinator, Dr. John Thistle.

Course requirements for the following Graduate Diploma areas are available through the Department of Electrical and Computer Engineering website.

Graduate Diploma in Software Engineering

Students will learn the concepts, techniques and methods of modern, effective software development. They will gain knowledge in software specifications, design and testing and will be exposed to data structures and algorithms, networking lower and upper layers, data-base systems, knowledge modeling, computational intelligence, component-based software engineering, re-engineering, and network security.

To receive the Graduate Diploma in Software Engineering, a student will have to successfully complete two compulsory courses and three elective courses.

Graduate Diploma in Sustainable Energy

Students will be exposed to different aspects of sustainable energy sources including the theory of operation and analysis of wind turbines, fuel cells and photovoltaic. Interfacing these energy sources with the electric utility grid and their effects on electricity market pricing will be addressed.
To receive the Graduate Diploma in Sustainable Energy, a student will have to successfully complete two compulsory courses and three elective courses.

- Graduate Diploma in Management Sciences (in Collaboration with the Department of Management Science)

Students can augment their technical knowledge gained from the courses in Electrical and Computer Engineering, with a broad perspective on technology management concepts. The students can learn about production and inventory management or economic concepts in management, organizational behaviour, or even senior management principles.

A student completing the MEng in ECE can obtain a Graduate Diploma in Management Sciences after successfully completing three courses.
Graduate Diploma (GDip) in Electric Power Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The Graduate Diploma (GDip) in Electric Power Engineering is an industry-oriented graduate-level program established as a cost-recovery program.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - Online

- Program type
  - Diploma

- Registration option(s)
  - Part-time

- Study option(s)
  - Coursework

Admission requirements

- Minimum requirements
  - An Honours Bachelor’s degree (or equivalent) with at least a 78% standing.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 2
  - Type of references: at least 1 academic.
• English Language Proficiency Certification (ELPC) (if applicable)

Diploma requirements

• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  o Students must successfully complete 6 courses (out of a choice of 18 courses offered in Electric Power Engineering):
    ▪ ECE 6601PD Power System Components and Modeling
    ▪ ECE 6602PD Power System Management and Electricity Markets
    ▪ ECE 6603PD Electromagnetic Compatibility and Power Quality
    ▪ ECE 6604PD Distributed Generation
    ▪ ECE 6605PD Power System Protection
    ▪ ECE 6606PD Distribution System Engineering
    ▪ ECE 6607PD Operation of Restructured Power Systems
    ▪ ECE 6608PD Dielectrics and Electrical Insulation
    ▪ ECE 6609PD High Voltage Engineering Applications
    ▪ ECE 6610PD Power Electronics Converters: Design and Applications
    ▪ ECE 6611PD Electric Machines and Motor Drives
    ▪ ECE 6612PD FACTS: Models, Controls and Applications
    ▪ ECE 6613PD Power System Analysis
    ▪ ECE 6614PD Industrial Utilization of Electrical Energy
    ▪ ECE 6615PD Design and Application of DC/DC Converters
    ▪ ECE 6616PD Electric Safety and Grounding System Design
    ▪ ECE 6617PD Asset Management and Risk Assessment of Power Systems
    ▪ ECE 6618PD Medium and HV Power Cables
  o A minimum grade of 65% in each of the 6 courses and a minimum cumulative average of 70% are required to remain in the program.

Department of Electrical and Computer Engineering website
The program is aimed at providing advanced level training, skill development and education to power engineering professionals employed at various power companies and utilities throughout the world, and in particularly in Canada, to help develop a specialized manpower base in the country.

Admission Requirements for the GDip in Electric Power Engineering are the same as those outlined for admission to the Master of Applied Science (MASc) degree. Visit the MEng Electric Power (online) webpage for detailed information about the program.

All courses within the program are offered in an e-learning, multi-media environment that is based on the "learn while you work" philosophy.
Graduate Diploma (GDip) in Management Sciences (in collaboration with the Department of Management Sciences)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Delivery mode(s)
  - On-campus

- Program type
  - Diploma

- Study option(s)
  - Coursework

Admission requirements

The GDip in Management Sciences is earned in conjunction with the Master of Engineering (MEng) in Electrical and Computer Engineering program.

Diploma requirements

- Courses
  - Students can augment their technical knowledge gained from the courses in Electrical and Computer Engineering, with a broad perspective on technology management concepts. The students can learn about production and inventory management or economic concepts in management, organizational behaviour, or even senior management principles.
  - To receive the GDip in Management Sciences, students must successfully complete 1 compulsory course and 3 elective courses.
    - Compulsory course:
      - ECE 602 Introduction to Optimization
    - Elective courses (choose 3 from the following list):
      - MSCI 602 Strategic Management Technology
      - MSCI 605 Organizational Theory & Behaviour
      - MSCI 607 Applied Economics for Management
      - MSCI 632 Discrete Event Simulation
      - MSCI 633 Production and Inventory Management
      - MSCI 638 Information Systems Analysis and Design
- MSCI 646 Database Management Systems
- MSCI 712 Decision Analysis Under Uncertainty
  - Note: Electrical and Computer Engineering MEng requirements allow for only 3 courses to be taken outside the Department.

Department of Electrical and Computer Engineering website
The Department of Electrical and Computer Engineering (ECE) offers four University-level diplomas, as outlined below.

The objectives of this program are:

- To train engineers with a more specialized technical background and specific focus that is recognized by the award of a Graduate Diploma.
- To offer a course-work based professional development graduate program for practicing engineers to be formally trained in the very topical areas of computer networking and security, software engineering, sustainable energy and management sciences.
- To provide new immigrants, foreign-trained engineers a degree program that facilitates entry to the Canadian workforce in important technical areas of significant national interest.
- To provide newly graduated engineers an opportunity to pursue graduate education in the very topical areas of computer networking and security, software engineering, sustainable energy and management sciences.

For additional program information please visit the Master of Engineering (MEng) webpage or contact the MEng Coordinator, Dr. John Thistle.

Course requirements for the following Graduate Diploma areas are available through the Department of Electrical and Computer Engineering website.

Graduate Diploma in Computer Networking and Security

Students will be exposed to the fundamental, advanced, and practical aspects of computer networks, security, and distributed computing systems. They will gain knowledge in the field of local and wide area networks - both wired and wireless. Students will learn designing network based systems for parallel and distributed processing; and the security aspects of communication and distributed system applications.

To receive the Graduate Diploma in Computer Networking and Security, a student will have to successfully complete three compulsory courses and two elective courses.

Graduate Diploma in Software Engineering

Students will learn the concepts, techniques and methods of modern, effective software development. They will gain knowledge in software specifications, design and testing and will be exposed to data structures and algorithms, networking lower and upper layers, data-base systems, knowledge modeling, computational intelligence, component-based software engineering, re-engineering, and network security.
To receive the Graduate Diploma in Software Engineering, a student will have to successfully complete two compulsory courses and three elective courses.

- Graduate Diploma in Sustainable Energy

Students will be exposed to different aspects of sustainable energy sources including the theory of operation and analysis of wind turbines, fuel cells and photovoltaic. Interfacing these energy sources with the electric utility grid and their effects on electricity market pricing will be addressed.

To receive the Graduate Diploma in Sustainable Energy, a student will have to successfully complete two compulsory courses and three elective courses.
Graduate Diploma (GDip) in Software Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Delivery mode(s)
  - On-campus

- Program type
  - Diploma

- Study option(s)
  - Coursework

Admission requirements

The GDip in Software Engineering is earned in conjunction with the Master of Engineering (MEng) in Electrical and Computer Engineering program.

Diploma requirements

- Courses
  - Students will learn the concepts, techniques and methods of modern, effective software development. They will gain knowledge in software specifications, design and testing and will be exposed to data structures and algorithms, networking lower and upper layers, data-base systems, knowledge modeling, computational intelligence, component-based software engineering, re-engineering, and network security.
  - To receive the GDip in Software Engineering, students must successfully complete 3 compulsory courses and 2 elective courses:
    - Compulsory courses:
      - ECE 650 Methods and Tools for Software Engineering
      - ECE 651 Foundations of Software Engineering
      - ECE 653 Software Testing, Quality Assurance and Maintenance
    - Elective courses (choose 2 from the following list):
      - ECE 606 Algorithm Design and Analysis
      - ECE 610 Broadband Communication Networks
      - ECE 628 Computer Network Security
      - ECE 654 Software Reliability Engineering

Note: not all elective courses may be offered each year.
- ECE 655 Protocols, Software, Issues in Mobile Systems
- ECE 656 Database Systems
- ECE 657 Tools of Intelligent Systems Design
- ECE 658 Component Based Software
  - Note: Electrical and Computer Engineering MEng requirements allow for only 3 courses to be taken outside the Department.

Department of Electrical and Computer Engineering website
The Department of Electrical and Computer Engineering (ECE) offers four University-level diplomas, as outlined below.

The objectives of this program are:

- To train engineers with a more specialized technical background and specific focus that is recognized by the award of a Graduate Diploma.
- To offer a course-work based professional development graduate program for practicing engineers to be formally trained in the very topical areas of computer networking and security, software engineering, sustainable energy and management sciences.
- To provide new immigrants, foreign-trained engineers a degree program that facilitates entry to the Canadian workforce in important technical areas of significant national interest.
- To provide newly graduated engineers an opportunity to pursue graduate education in the very topical areas of computer networking and security, software engineering, sustainable energy and management sciences.

For additional program information please visit the Master of Engineering (MEng) webpage or contact the MEng Coordinator, Dr. John Thistle.

Course requirements for the following Graduate Diploma areas are available through the Department of Electrical and Computer Engineering website.

Graduate Diploma in Computer Networking and Security

Students will be exposed to the fundamental, advanced, and practical aspects of computer networks, security, and distributed computing systems. They will gain knowledge in the field of local and wide area networks - both wired and wireless. Students will learn designing network based systems for parallel and distributed processing; and the security aspects of communication and distributed system applications.

To receive the Graduate Diploma in Computer Networking and Security, a student will have to successfully complete three compulsory courses and two elective courses.

Graduate Diploma in Sustainable Energy

Students will be exposed to different aspects of sustainable energy sources including the theory of operation and analysis of wind turbines, fuel cells and photovoltaic. Interfacing these energy sources with the electric utility grid and their effects on electricity market pricing will be addressed.
To receive the Graduate Diploma in Sustainable Energy, a student will have to successfully complete two compulsory courses and three elective courses.

- **Graduate Diploma in Management Sciences (in Collaboration with the Department of Management Science)**

  Students can augment their technical knowledge gained from the courses in Electrical and Computer Engineering, with a broad perspective on technology management concepts. The students can learn about production and inventory management or economic concepts in management, organizational behaviour, or even senior management principles.

  A student completing the MEng in ECE can obtain a Graduate Diploma in Management Sciences after successfully completing three courses.
Graduate Diploma (GDip) in Sustainable Energy

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Delivery mode(s)
  - On-campus

- Program type
  - Diploma

- Study option(s)
  - Coursework

Admission requirements

The GDip in Sustainable Energy is earned in conjunction with the Master of Engineering (MEng) in Electrical and Computer Engineering program.

Diploma requirements

- Courses
  - Students will be exposed to different aspects of sustainable energy sources including the theory of operation and analysis of wind turbines, fuel cells and photovoltaic. Interfacing these energy sources with the electric utility grid and their effects on electricity market pricing will be addressed.
  - To receive the GDip in Sustainable Energy, students must successfully complete 2 compulsory courses and 3 elective courses.
    - Compulsory courses:
      - ECE 663 Energy Processing
      - ECE 668 Distribution Systems Engineering
    - Elective courses (choose 3 from the following list):
      - Note: not all elective courses may be offered each year.
      - ECE 632 Photovoltaic Energy Conversion
      - ECE 661 HVDC and FACTS
      - ECE 662 Power System Analysis and Control
      - ECE 664 Power System Components and Modelling
      - ECE 665 High Voltage Engineering Applications
      - ECE 666 Power System Operation
- ECE 667 Sustainable Distributed Power Generation
- ECE 669 Dielectric Materials
- ECE 768 Power System Quality
  - Note: Electrical and Computer Engineering MEng requirements allow for only 3 courses to be taken outside the Department.

Department of Electrical and Computer Engineering website
The Department of Electrical and Computer Engineering (ECE) offers four University-level diplomas, as outlined below.

The objectives of this program are:
- To train engineers with a more specialized technical background and specific focus that is recognized by the award of a Graduate Diploma.
- To offer a course-work based professional development graduate program for practicing engineers to be formally trained in the very topical areas of computer networking and security, software engineering, sustainable energy and management sciences.
- To provide new immigrants, foreign-trained engineers a degree program that facilitates entry to the Canadian workforce in important technical areas of significant national interest.
- To provide newly graduated engineers an opportunity to pursue graduate education in the very topical areas of computer networking and security, software engineering, sustainable energy and management sciences.

For additional program information please visit the Master of Engineering (MEng) webpage or contact the MEng Coordinator, Dr. John Thistle.

Course requirements for the following Graduate Diploma areas are available through the Department of Electrical and Computer Engineering website.

Graduate Diploma in Computer Networking and Security

Students will be exposed to the fundamental, advanced, and practical aspects of computer networks, security, and distributed computing systems. They will gain knowledge in the field of local and wide area networks - both wired and wireless. Students will learn designing network based systems for parallel and distributed processing; and the security aspects of communication and distributed system applications.

To receive the Graduate Diploma in Computer Networking and Security, a student will have to successfully complete three compulsory courses and two elective courses.

Graduate Diploma in Software Engineering

Students will learn the concepts, techniques and methods of modern, effective software development. They will gain knowledge in software specifications, design and testing and will be exposed to data structures and algorithms, networking lower and upper layers, data-base systems, knowledge modeling, computational intelligence, component-based software engineering, re-engineering, and network security.
To receive the Graduate Diploma in Software Engineering, a student will have to successfully complete two compulsory courses and three elective courses.

- Graduate Diploma in Management Sciences (in Collaboration with the Department of Management Science)

Students can augment their technical knowledge gained from the courses in Electrical and Computer Engineering, with a broad perspective on technology management concepts. The students can learn about production and inventory management or economic concepts in management, organizational behaviour, or even senior management principles.

A student completing the MEng in ECE can obtain a Graduate Diploma in Management Sciences after successfully completing three courses.
Master of Applied Science (MASc) in Electrical and Computer Engineering - Nanotechnology

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Length of program
  - The minimum period of registration for the Master's degree is two terms after an Honours Bachelor's degree or equivalent. The maximum time limit is six terms for the regular program and fifteen terms for the part-time program. Extensions beyond six terms must be approved by the Faculty Graduate Studies Office.

- Program type
  - Master’s
  - Collaborative
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - An Honours Bachelor's degree (or equivalent) with at least a 78% standing.
  - At the time of admission, each student must have a faculty supervisor who has endorsed the recommendation for admission.
• Application materials
  o Résumé
  o Supplementary information form
  o Transcript(s)

• References
  o Number of references: 2
  o Type of references: at least 1 academic.

• English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  o Students must complete a total of at least 5 courses (0.50 unit weight) including 2
    required Nanotechnology core courses and 3 elective courses from the list of technical
    electives, the choice of courses must meet with the approval of the supervisor.
  o Students who have completed their Bachelor of Applied Science (BASc) degree in
    Nanotechnology Engineering at the University of Waterloo will not be required to take
    the 2 core courses. Instead, they can choose all graduate courses from the list of
    technical electives to meet the total course credit requirement.
  o Nanotechnology core courses:
    ▪ NANO 701 Fundamentals of Nanotechnology (students must complete any 2 of
      the 0.25 unit weight modules)
    ▪ NANO 702 Nanotechnology Tools (students must complete any 2 of the 0.25 unit
      weight modules)
  o Technical elective courses:
    ▪ (a) Micro/nano Instruments and Devices
      • BIOL 642 Current topics in Biotechnology
      • CHEM 750T17 Surface Science and Nanotechnology
      • CHEM 750TX Nanostructured Materials and Analysis
      • CHEM 724 Chemical Instrumentation
      • ME 770 Topics in Heat and Fluid Flow: Micro- and Nano- fluidics
      • ME 738 Topics in Materials Science: Materials for NEMS and MEMS
      • ME 780 Topics in Mechatronics: MEMS Design and Analysis
      • SYDE 682 Advanced MEMS Physics, Design and Fabrication
      • SYDE 750 Modeling, Simulation and Design of MEMS
    ▪ (b) Nanoelectronics Design and Fabrication
      • CHEM 750T11 Bioelectronics
- CHEM 750T19 Carbon Nanotube Electronics
- ECE 631 Microelectronic Processing Technology
- ECE 632 Photovoltaic Energy Conversion
- ECE 633 Nanoelectronics
- ECE 634 Organic Electronics
- ECE 635 Fabrication in the Nanoscale: Technology and Applications
- ECE 636 Analog MOS and Bipolar Integrated Circuits
- ECE 637 Design of VLSI MOS Integrated Circuits
- ECE 639 Characteristics & Applications of Amorphous Silicon
- ECE 672 Optoelectronic Devices
- ECE 676 Quantum Info Processing Devices
- ECE 677 Quantum Electronics & Photonics
- ECE 730T17 Topics in Solid State Devices: Physics and Modeling of Semiconductor Devices
- ECE 730T19 Topics in Solid State Devices: Magnetism and Spintronics
- ECE 730T20 Topics in Solid State Devices: Physics of Nanodevices
- ECE 770T13 Topics in Antenna and Microwave Theory: Quantum Information Devices
- ME 595 Introduction to MEMS Fabrication
- ME 596 Topics in Nanotechnology: Introduction to Fabrication & Characterization of Nano-structures
- PHYS 713 Molecular Physics
- PHYS 731 Solid State Physics
- PHYS 747 Optical Electronics

(c) Nano-biosystems
- BIOL 608 Advanced Molecular Genetics
- BIOL 614 Bioinformatics Tools and Techniques
- BIOL 629 Cell Growth and Differentiation
- BIOL 642 Current Topics in Biotechnology
- BIOL 670 Photobiology
- BIOL 678 Current topics in Neurophysiology
- CHE 562 Advanced Bioprocess Engineering
- CHE 660 Principles of Biochemical Engineering
- CHE 661 Advances in Biochemical Engineering
- CHE 760 Special Topics in Biochemical Engineering
- CHE 765 Research Topics in Biochemical Engineering
- CHEM 730 Proteins and Nucleic Acids
- CHEM 731T02 Physical Biochemistry
• CHEM 737 Enzymes
• PHYS 751 Cellular Biophysics
• PHYS 752 Molecular Biophysics
  ▪ (d) Nanomaterials
    • CHE 541 Introduction to Polymer Science and Properties
    • CHE 542 Polymerization and Polymer Properties
    • CHE 612 Interfacial Phenomena
    • CHE 622 Statistics in Engineering
    • CHE 640 Principles of Polymer Science (Cross-listed with CHEM 770)
    • CHE 641 Physical Properties of Polymers (Cross-listed with CHEM 771)
    • CHE 740 Special Topics in Polymer Science and Engineering
    • CHE 750 Special Topics in Materials Science: Thin Film Fabrications & Mechanical Properties
    • CHE 755 Research Topics in Electrochemical Engineering, Interfacial Engineering & Material Science
    • CHE 745 Research Topics in Polymer Science and Engineering
    • CHEM 710T12 Structure and Function of Supramolecular Materials
    • CHEM 710T15 Advanced Solid State Chemistry: Ion, Electron and Molecular Transport
    • CHEM 710TX Nanostructured Materials and Integrative Chemistry
    • CHEM 713 Chemistry of Inorganic Solid State Materials
    • CHEM 750T17 Surface Science and Nanotechnology
    • ME 632 Experimental Methods in Materials Engineering
    • ME 738 Topics in Materials Science: Materials for NEMS and MEMS
    • ME 738 Topics in Materials Science: Nanostructured and Amorphous Materials
    • ME 738T8 Topics in Materials Science: Introductory and Advanced Nanomechanics
    • PHYS 701 Quantum Mechanics
    • PHYS 704 Statistical Physics
    • PHYS 706 Electromagnetic Theory
    • PHYS 773 Special Topics
  
  ▪ Students may be required at any time to withdraw from the program if they fail to maintain a minimum grade of 65% in each of the 5 courses and a cumulative average of at least 70% in the coursework portion of their approved study program or if they fail to receive satisfactory progress reports regarding their research activities.
  
  ▪ The Department may recommend that credit be allowed for courses taken at other institutions. In special cases, 1 course (0.50 unit weight) may be approved.

• Nanotechnology Seminar
This seminar is a forum for student presentation of research results or proposals. The range of topics that will be addressed in the seminar crosses all areas of research in the collaborative program. Each student is required to present at least 1 Nanotechnology research seminar over the course of the degree. The Nanotechnology Seminar may simultaneously count towards the Master’s Seminar requirement of the ECE Department.

• Master’s Seminar
  o Students are required to present a seminar on their thesis topic as part of the degree requirements. The purpose of this seminar is to develop the student’s ability to communicate the results of a research work in an organized and informative manner. The seminar is not an oral examination of the thesis. The seminar should be held during the term the thesis is submitted to the readers. The supervisor(s), plus one other Faculty member must be in attendance at the seminar in order for the student to receive credit.

• Master’s Thesis
  o The topic of the thesis and the choice of the required 5 courses of graduate coursework are arranged by students and their faculty supervisor. Each student’s program is subject to approval by the Graduate Studies Committee of the Department. Students must maintain continuous active registration until the thesis requirements are completed. The research work leading to the thesis must be performed under the direction of the faculty supervisor(s) and is finally approved and accepted by at least three readers. The readers will consist of the supervisor(s) plus a minimum of two other faculty members.

Department of Electrical and Computer Engineering website
Waterloo Institute for Nanotechnology website
The University of Waterloo offers the first Master of Applied Science (MASc) and Doctor of Philosophy (PhD) programs in Nanotechnology of its kind in Canada. The interdisciplinary research programs, jointly offered by three departments in the Faculty of Science and four in the Faculty of Engineering, provide students with a stimulating educational environment that spans from basic research through to application. The goal of the collaborative programs is to allow students to gain perspectives on nanotechnology from a wide community of scholars within and outside their disciplines in both course and thesis work.

The MASc degree collaborative program provides a strong foundation in the emerging areas of nano-science or nano-engineering in preparation for the workforce or for further graduate study and research leading to a doctoral degree. Four key areas of research strengths have been identified: nanomaterials, nano-electronics design and fabrication, nano-instruments and devices, and nano-biosystems. The objective of the PhD program is to prepare students for careers in academia, industrial R & D and government research labs. Students from Science and Engineering will work side-by-side in world class laboratory facilities namely, the Giga-to-Nano Electronics Lab (G2N), Waterloo Advanced Technology Lab (WatLAB) and the new 225,000 gross sq. ft. Nano-Quantum Center expected to be completed in early 2011.

There are nearly 50 faculty members involved in nanotechnology research at the university with many who are internationally renowned leaders in their fields. Among them are seven Canada Research Chairs and two NSERC Industrial Research Chairs.

Admission requirements are the same as home department programs. The home department in which the applicant intends to pursue graduate study must approve the application. Interested students should apply directly to one of the following departments via the regular university application process:

Biology
Chemical Engineering
Chemistry
Electrical and Computer Engineering
Mechanical and Mechatronics Engineering
Physics and Astronomy
Systems Design Engineering

Financial Support

All graduate students engaged in MASc and PhD studies at the University of Waterloo receive financial support. In addition, students admitted into the collaborative Nanotechnology graduate program are also eligible to apply for Fellowships in Nanotechnology, valued at CDN
$10,000 each, through the Waterloo Institute for Nanotechnology (WIN). Fellowship funding is on top of the research support from the supervising Faculty Member and can be held simultaneously with other graduate awards (subject to the requirements of other scholarships/awards). Additional information is available at the Waterloo Institute for Nanotechnology website.

- Admission Requirements

Admission requirements are the same as those for the MASc in Electrical and Computer Engineering.

- Note: It is possible that some students may need to take more courses than are prescribed by the home department in order to meet the specific course requirements of the collaborative program.

- The MASc degree requirements are as follows:

- Generally, students are required to take two core courses and complete the Nanotechnology Seminar. All core courses have written examinations, as do all ECE graduate courses.

- Technical Electives

Approved technical elective courses (pdf)
Master of Applied Science (MASc) in Electrical and Computer Engineering - Quantum Information

Students are responsible for reviewing the [General Information and Regulations section of the Graduate Studies Academic Calendar](#).

Program information

- **Admit term(s)**
  - Fall
  - Winter
  - Spring

- **Delivery mode(s)**
  - On-campus

- **Length of program**
  - The minimum period of registration for the Master's degree is two terms after an Honours Bachelor's degree or equivalent. The maximum time limit is six terms for the regular program and fifteen terms for the part-time program. Extensions beyond six terms must be approved by the Faculty Graduate Studies Office.

- **Program type**
  - Master's
  - Collaborative
  - Research

- **Registration option(s)**
  - Full-time
  - Part-time

- **Study option(s)**
  - Thesis

Admission requirements

- **Minimum requirements**
  - An Honours Bachelor's degree (or equivalent) with at least a 78% standing.
  - At the time of admission, each student must have a faculty supervisor who has endorsed the recommendation for admission.
• Application materials
  o Résumé
  o Supplementary information form
  o Transcript(s)

• References
  o Number of references: 2
  o Type of references: at least 1 academic.

• English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  o Students must complete at least 5 half credit (0.50 unit weight) courses including 3 core courses and 2 elective courses from the approved lists below:
  o Quantum Information core courses:
    ▪ QIC 710 Quantum Information Processing
    ▪ QIC 750/ECE 676 Implementation of Quantum Information Processing
    ▪ QIC 885/ECE 677 Quantum Electronics & Photonics
  o 1 of the following electives:
    ▪ ECE 612 Information Theory
    ▪ ECE 604 Stochastic Processes
    ▪ ECE 672 Optoelectronic Devices
    ▪ ECE 720 Special Topics in Computers and Digital Systems Software (2 Cryptographic Computations)
  o 1 of the following electives:
    ▪ ECE 633 Nanoelectronics
    ▪ ECE 635 Fabrication of Nanoscale: Techniques & Applications
    ▪ ECE 671 Microwave and RF Engineering
    ▪ ECE 730 Special Topics in Solid State Devices (19 Magnetism and Spintronics, 20 Physics of Nanodevices)
    ▪ ECE 770 Special Topics in Antenna and Microwave Theory (5 App High Temp Superconduc, 17 Photonics)
  o Quantum Information core courses are interdisciplinary courses designed to provide students with the foundations and applications of quantum information processing, and implementations of quantum information processing.
  o The choice of courses must meet with the approval of the supervisor.
Students may be required at any time to withdraw from the program if they fail to maintain a minimum grade of 65% in each of the 5 courses and a cumulative average of at least 70% in the coursework portion of their approved study program or if they fail to receive satisfactory progress reports regarding their research activities.

The Department may recommend that credit be allowed for courses taken at other institutions. In special cases, 1 course (0.50 unit weight) may be approved.

- **Master’s Seminar**
  - Students are required to present a seminar on their thesis topic as part of the degree requirements. The purpose of this seminar is to develop the student’s ability to communicate the results of a research work in an organized and informative manner. The seminar is not an oral examination of the thesis. The seminar should be held during the term the thesis is submitted to the readers. The supervisor(s), plus one other Faculty member must be in attendance at the seminar in order for the student to receive credit.

- **Master’s Thesis**
  - Students must complete an original research thesis, in Quantum Information.
  - The topic of the thesis and the choice of the required 5 courses of graduate coursework are arranged by students and their faculty supervisor. Each student's program is subject to approval by the Graduate Studies Committee of the Department. Students must maintain continuous active registration until the thesis requirements are completed. The research work leading to the thesis must be performed under the direction of the faculty supervisor(s) and is finally approved and accepted by at least three readers. The readers will consist of the supervisor(s) plus a minimum of two other faculty members.
  - A list of approved Quantum Information thesis supervisors is available on the [Department of Electrical and Computer Engineering website](http://www.ece.mcgill.ca).
• The University of Waterloo, home of the Institute for Quantum Computing, offers graduate students unique opportunities to learn about and engage in world-leading research in quantum information through a wide range of advanced research projects and advanced courses on the foundations, applications and implementation of quantum information processing.

In particular, the University of Waterloo offers a unique interdisciplinary graduate program in Quantum Information that leads to Master of Mathematics (MMath), Master of Science (MASc), Master of Applied Science (MASc), and Doctor of Philosophy (PhD) degrees. This program is a collaboration between the Institute for Quantum Computing and:

The Departments of Applied Mathematics, Combinatorics and Optimization, and the David R. Cheriton School of Computer Science in the Faculty of Mathematics
The Departments of Chemistry and Physics and Astronomy in the Faculty of Science
The Department of Electrical and Computer Engineering in the Faculty of Engineering

These academic units are referred to hereinafter as the home units.

MMath, MSc, and MASc students will receive both strong and broad foundations in quantum information science, coupled with knowledge and expertise obtained within their home programs. This will prepare them for the workforce and/or further graduate studies and research leading towards a PhD degree.

PhD students will be especially well-prepared for careers as scholars and researchers, with advanced expertise in quantum information science, together with the focus of their home programs. This new program is designed to provide students with knowledge of quantum information, including both theory and its implementations, advanced expertise in quantum information science and in home program disciplines, as well as training in research.

Admission requirements are the same as those of the home programs. The home unit in which an applicant intends to pursue graduate study must approve the application. Interested students should apply directly to one of the following units via the regular university application process:

Department of Applied Mathematics
Department of Chemistry
Department of Combinatorics and Optimization
David R. Cheriton School of Computer Science
Department of Electrical and Computer Engineering
Department of Physics and Astronomy
Information specific to the Department of Electrical and Computer Engineering is given below.

- **Admission Requirements**

  Admission requirements are the same as those for the MASc in Electrical and Computer Engineering.

- **Students** must fulfill the general requirements for the Quantum Information Collaborative Program, as well as the minimum degree requirements of their home unit. It is possible that some students may need to take more courses than are prescribed by the home program in order to meet the specific course requirements of the quantum information program.

- **Thesis MASc Program:** The MASc in ECE Quantum Information degree requirements are as follows:
  - **ECE MASc Seminar Milestone** (scheduled with the ECE department)
  - Students in the Quantum Information program are required to take both courses.
  - A list of Quantum Information courses that are offered each term can be found on the Institute for Quantum Computing website.
  - For more information about the program, please contact the Department of Electrical and Computer Engineering Graduate Studies Office.
Master of Applied Science (MASc) in Electrical and Computer Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Antennas, Microwaves and Wave Optics
- Circuits and Systems Including Computer - Aided Design
- Communications and Information Systems
- Computer Hardware
- Computer Software
- Nanotechnology
- Pattern Analysis and Machine Intelligence (PAMI)
- Power and Energy Systems
- Quantum Information
- Silicon Devices and Integrated Circuits
- Systems and Control
- Very Large Scale Integration (VLSI)
- Wireless Communication

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Length of program
  - The minimum period of registration for the Master's degree is two terms after an Honours Bachelor's degree or equivalent. The maximum time limit is six terms for the regular program and fifteen terms for the part-time program. Extensions beyond six terms must be approved by the Faculty Graduate Studies Office.

- Program type
  - Master's
  - Research
• Registration option(s)
  o Full-time
  o Part-time

• Study option(s)
  o Thesis

Admission requirements

• Minimum requirements
  o An Honours Bachelor's degree (or equivalent) with at least a 78% standing.
  o At the time of admission, each student must have a faculty supervisor who has endorsed the recommendation for admission.

• Application materials
  o Résumé
  o Supplementary information form
  o Transcript(s)

• References
  o Number of references: 2
  o Type of references: at least 1 academic.

• English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  o The requirements for the program consist of at least 5 courses (0.50 unit weight per course) of graduate credit. A minimum of 3 courses must be taken from within the Faculty of Engineering. A maximum of 2 courses may be taken from outside the Faculty but must be from the Faculties of Math and/or Science. At least 2 of the courses must be from the list of approved core courses (updated by the Department annually) in one of the approved areas of specialization as specified in the student's letter of admission. The choice of courses must meet with the approval of the supervisor.
  o Core courses:
    • Antennas, Microwaves, and Wave Optics
      • ECE 642 Radio Frequency Integrated Circuit Design
      • ECE 671 Microwave and RF Engineering
      • ECE 672 Optoelectronic Devices
• ECE 675 Radiation and Propagation of Electromagnetic Fields
• ECE 676 (QIC 750) Quantum Information Processing Devices
• ECE 677 (QIC 885) Quantum Electronics and Photonics

□ Circuits and Systems
• ECE 636 Advanced Analog Integrated Circuits
• ECE 637 Digital Integrated Circuits
• ECE 671 Microwave and RF Engineering

□ Communications and Information Systems
• ECE 603 Statistical Signal Processing
• ECE 604 Stochastic Processes
• ECE 610 Broadband Communication Networks
• ECE 611 Digital Communications
• ECE 612 Information Theory

□ Computer Hardware
• ECE 606 Algorithm Design
• ECE 621 Computer Organization
• ECE 627 Register-transfer-level Digital Systems
• ECE 637 Digital Integrated Circuits

□ Computer Software
• ECE 606 Algorithm Design and Analysis
• ECE 650 Methods and Tools for Software Engineering
• ECE 653 Software Testing, Quality Assurance and Maintenance
• ECE 654 Software Reliability Engineering
• ECE 656 Database Systems

□ Nanotechnology
• ECE 630 Physics and Models of Semiconductor Devices
• ECE 633 Nanoelectronics
• ECE 634 Organic Electronics
• ECE 635 Fabrication in the Nanoscale: Principles, Technology and Applications
• ECE 672 Optoelectronic Devices

□ PAMI - Pattern Analysis and Machine Intelligence
• ECE 606 Algorithm Design and Analysis
• ECE 613 Image Processing and Visual Communication
• ECE 657 Tools of Intelligent Systems Design
• ECE 657A Data and Knowledge Modelling and Analysis
• ECE 659 Intelligent Sensors and Sensor Networks

□ Power and Energy Systems
• ECE 662 Power Systems Analysis and Control
• ECE 663 Energy Processing
- ECE 665 High Voltage Engineering Applications
- ECE 666 Power Systems Operation
- ECE 668 Distribution System Engineering

- Quantum Information
  - QIC 710 Quantum Information Processing
  - ECE 676 (QIC750) Quantum Information Processing Devices
  - ECE 677(QIC 885) Quantum Electronics and Photonics

- Silicon Devices and Integrated Circuits
  - ECE 630 Physics and Models of Semiconductor Devices
  - ECE 631 Microelectronic Processing Technology
  - ECE 634 Organic Electronics
  - ECE 636 Advanced Analog Integrated Circuits
  - ECE 671 Microwave and RF Engineering
  - ECE 672 Optoelectronic Devices

- Systems and Controls
  - ECE 602 (CO 602) Introduction to Optimization
  - ECE 604 (STAT 901) Stochastic Processes
  - ECE 682 Multivariable Control Systems
  - ECE 686 Filtering and Control of Stochastic Linear Systems
  - ECE 688 Nonlinear Systems

- VLSI - Very Large Scale Integration
  - ECE 636 Advanced Analog Integrated Circuits
  - ECE 637 Digital Integrated Circuits
  - ECE 671 Microwave and RF Engineering

- Wireless Communication
  - ECE 603 Statistical Signal Processing
  - ECE 604 Stochastic Processes
  - ECE 610 Broadband Communication Networks
  - ECE 611 Digital Communications
  - ECE 612 Information Theory

- Students are normally expected to take graduate courses at the 600 or 700 level. 1 advanced undergraduate (400 level) Electrical or Computer Engineering course may be allowed for graduate credit. It is expected that both the student and supervisor should provide adequate justification and complete the required paperwork before any undergraduate course is approved for credit.

- The advanced undergraduate courses must be at the 400 or 500 level as given in the Undergraduate Studies Academic Calendar and must be approved for graduate credit and confirmed in writing by the Department Associate Chair for Graduate Studies at the time of registration.

- Students may be required at any time to withdraw from the program if they fail to maintain a minimum grade of 65% in each of the 5 courses and a cumulative average of
at least 70% in the coursework portion of their approved study program or if they fail to receive satisfactory progress reports regarding their research activities.

- The Department may recommend that credit be allowed for courses taken at other institutions. In special cases, 2 courses (0.50 unit weight) may be approved.

- Master’s Seminar
  - Students are required to present a seminar on their thesis topic as part of the degree requirements. The purpose of this seminar is to develop the student’s ability to communicate the results of a research work in an organized and informative manner. The seminar is not an oral examination of the thesis. The seminar should be held during the term the thesis is submitted to the readers. The supervisor(s), plus one other Faculty member must be in attendance at the seminar in order for the student to receive credit.

- Master’s Thesis
  - The topic of the thesis and the choice of the required 5 courses of graduate coursework are arranged by students and their faculty supervisor. Each student’s program is subject to approval by the Graduate Studies Committee of the Department. Students must maintain continuous active registration until the thesis requirements are completed. The research work leading to the thesis must be performed under the direction of the faculty supervisor(s) and is finally approved and accepted by at least three readers. The readers will consist of the supervisor(s) plus a minimum of two other faculty members.

Department of Electrical and Computer Engineering website
The regular Master of Applied Science (MASc) program, may be pursued through a thesis option. The MASc - Software Engineering Program (ConGESE) may be completed with either a thesis or research/design paper. Admission requirements for students admitted to the MASc program are as follows:

- Proof of competency in English (if applicable). See the English Language Proficiency page for acceptable tests of English.

- A Supplementary Information form (available through the on-line application process). Note: This is not a requirement for the MASc - Software Engineering (ConGESE) program.

- Students who do not meet the requirements outlined above may be considered for admission to a transitional, probationary or qualifying program depending on their academic backgrounds. Refer to the Categories of Admission page for additional information.

- The objective of the regular MASc degree program in Electrical and Computer Engineering is to demonstrate individual accomplishment of high professional and academic standard. The candidate, with the approval of the supervisor, must submit a research thesis as a portion of the requirements.

- The thesis counts as 4 (0.50 unit weight) courses.

- ...as noted in this calendar.

- MASc - Software Engineering (ConGESE)

Note: The Department of Electrical and Computer Engineering is no longer accepting applications for the ConGESE program.

In addition to satisfying all other requirements for the regular MASc degree, a student pursuing a specialization in software engineering must take courses to satisfy the Software Engineering (ConGESE) requirements which place emphasis on core software engineering material, project management material, software technology material, application engineering material, and related electives.

This program offers a thesis or research paper option. Thesis requirements are the same as those of the regular MASc program. The research paper option requires completion of at least 8 courses (0.50 unit weight per course) of graduate credit plus a research paper (Master's Research Paper Milestone). The research paper counts as two (0.50 unit weight) courses.
• Master's Research Paper

The topic of the research paper is arranged by the student and the faculty supervisor for approval by the Graduatae Studies Committee. The work leading to the project report must be performed under the direction of the supervisor. The report must then be approved and accepted by the supervisor and one reader.
Master of Engineering (MEng) in Electrical and Computer Engineering - Electric Power Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The Master of Engineering (MEng) in Electrical and Computer Engineering - Electric Power Engineering program is an industry-oriented cost recovery graduate program.

**Program information**

- **Admit term(s)**
  - Fall
  - Winter
  - Spring

- **Delivery mode(s)**
  - Online

- **Program type**
  - Master’s
  - Professional

- **Registration option(s)**
  - Part-time

- **Study option(s)**
  - Coursework

**Admission requirements**

- **Minimum requirements**
  - An Honours Bachelor’s degree (or equivalent) with at least a 78% standing.

- **Application materials**
  - Résumé
  - Supplementary information form
  - Transcript(s)

- **References**
 Degree requirements

- English Language Proficiency Certification (ELPC) (if applicable)

Courses

- The program offers a wide spectrum of courses that are relevant to the power industry dealing with the latest state-of-the-art developments in the field. Students must successfully complete 9 courses (out of a choice of 18 courses offered in Electric Power Engineering):
  - ECE 6601PD Power System Components and Modeling
  - ECE 6602PD Power System Management and Electricity Markets
  - ECE 6603PD Electromagnetic Compatibility and Power Quality
  - ECE 6604PD Distributed Generation
  - ECE 6605PD Power System Protection
  - ECE 6606PD Distribution System Engineering
  - ECE 6607PD Operation of Restructured Power Systems
  - ECE 6608PD Dielectrics and Electrical Insulation
  - ECE 6609PD High Voltage Engineering Applications
  - ECE 6610PD Power Electronics Converters: Design and Applications
  - ECE 6611PD Electric Machines and Motor Drives
  - ECE 6612PD FACTS: Models, Controls and Applications
  - ECE 6613PD Power System Analysis
  - ECE 6614PD Industrial Utilization of Electrical Energy
  - ECE 6615PD Design and Application of DC/DC Converters
  - ECE 6616PD Electric Safety and Grounding System Design
  - ECE 6617PD Asset Management and Risk Assessment of Power Systems
  - ECE 6618PD Medium and HV Power Cables

- A minimum grade of 65% in each of the 9 courses and a minimum cumulative average of 70% are required to remain in the program.
The focus of this program is on advanced level training, skill development and education of power engineering professionals employed at various power companies and utilities worldwide and particularly in Canada, to help develop a specialized manpower base in the country.

This is an on-line program wherein all courses are offered in a web-based environment using the latest state-of-the-art communication and multimedia technology. This program is the first of its kind in Canada. The on-line course delivery mechanism provides an opportunity to working power engineering professionals around the world to participate and upgrade their knowledge, and is based on the "learn while you work" philosophy.

Admission requirements are the same as those for the Master of Applied Science (MASc) degree. See the Graduate Studies Office Application and admission page for additional information.

Visit the MEng Electric Power (online) webpage for more detailed information on the program.
Master of Engineering (MEng) in Electrical and Computer Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Length of program
  - The minimum period of full-time registration for the program is three terms and the maximum allowable time is six terms of active registration. For part-time students, the minimum period of registration for the program is six terms and the maximum allowable time is fifteen consecutive terms.

- Program type
  - Master's
  - Professional

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Coursework

Admission requirements

- Minimum requirements
  - An Honours Bachelor's degree (or equivalent) with at least a 78% standing.

- Application materials
  - Résumé
  - Supplementary information form
- Transcript(s)

- References
  - Number of references: 2
  - Type of references: at least 1 academic.

- English Language Proficiency Certification (ELPC) (if applicable)

**Degree requirements**

- [Graduate Academic Integrity Module (Graduate AIM)](#)

- **Courses**
  - Students must successfully complete 8 one-term courses (0.50 unit weight) acceptable for credit by the Department.
  - Students may register for any ECE course at the 600 or 700 levels.
  - A minimum of 5 courses must be taken from within the ECE Department but must be from the faculties of Engineering, Math and Science.
  - A minimum grade of 65% in each of the 8 courses and a minimum cumulative average of 70% are required to remain in the program.
  - Students wishing to complete one of the four Graduate Diplomas as part of their MEng program should consult the list of required courses for each Diploma before selecting courses.

[Department of Electrical and Computer Engineering website](#)
The Master of Engineering (MEng) is an ideal option for the new graduate looking to quickly specialize in a competitive job market, the new Canadian seeking new skills and credentials from a leading Canadian University or the industry professional who is thinking about accelerating his or her career. The MEng program allows you to gain new skills and credibility to help you engineer your future. The program is designed with the professional in mind and is based on industry relevant course work.

The MEng program in Electrical and Computer Engineering focuses on advanced background education and skill development. A student who graduates from the Department of Electrical and Computer Engineering with an MEng degree will have a strong theoretical background and development skills which are appropriate both for the analysis and design of industrial systems.

Please refer to the Electrical and Computer Engineering website for additional information.

Admission requirements for the MEng program are the same as the admission requirements for the Master of Applied Science (MASc) program and include:

- Proof of competency in English (if applicable). See the English Language Proficiency page for acceptable tests of English.
- A Supplementary Information form (available through the on-line application process).
- Please refer to the University application requirements listing for full admission requirements by program and access to the on-line application procedures.
- For additional information on the regulations governing this program, please refer to the Electrical and Computer Engineering website.
Accelerated Master's Program in Electrical and Computer Engineering
(open to University of Waterloo Bachelor of Applied Science students only)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The Faculty of Engineering offers an Accelerated Bachelor's-Master's Program to high achieving University of Waterloo undergraduate students who are interested in pursuing graduate studies. Students must apply for admission to the Accelerated program in their 3B term. If admitted to the Master of Applied Science (MASc) program, students will undertake graduate work during their 4A and 4B terms. The Bachelor's degree is awarded at the normal completion of the undergraduate program; graduate course credits (maximum of 2) are applied to the Master's program resulting in a reduction in the number of terms required to complete the MASc program.

Individual Faculty of Engineering Departments may set requirements higher than the minimum requirements for the Accelerated Program.

Electrical and Computer Engineering (ECE) Accelerated BASc-MASc Program requirements

The ECE Department will only consider applicants to this program if they meet the 80% overall average requirement. The MASc program requires completion of 5 graduate level courses (0.50 unit weight per course) plus a thesis and a graduate seminar. There is no project option in ECE. At least 2 of the courses must be from the list of approved core courses (updated by the Department annually) in one of the approved areas of specialization as specified in the student's letter of admission. The choice of courses must meet with the approval of the supervisor.

ECE supervisors have to be found for students before they are admitted to this program even though they may satisfy the academic requirements. Interested students are encouraged to talk to individual ECE faculty members and explore possibilities of supervision. Both the academic program and financial details should be worked out between the student and the supervisor. These arrangements must then be approved by the ECE Associate Chair for Graduate Studies.

Coursework

Students accepted to the BASc-MASc accelerated program can take, during their 4A or 4B terms or during their undergraduate work term, as extra to degree, an approved ECE graduate course which could count towards their MASc degree. This course will not count towards their BASc degree requirements and can only be taken with the approval of the graduate course instructor, their supervisor, and the ECE Associate Chair for Graduate Studies.
With approval of the supervisor and ECE Associate Chair for Graduate Studies, work done by students during their fourth-year work term(s) under the direction of the supervisor can be included in their MASc thesis provided this work was not used for an ECE 499 project. Note: if the work is done in industry, permission from the company for the work to be published will be necessary.

Department of Electrical and Computer Engineering website
Doctor of Philosophy (PhD) in Mechanical and Mechatronics Engineering - Nanotechnology

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Doctoral
  - Collaborative
  - Research

- Registration option(s)
  - Full-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - A thesis-based Master's degree from a university of recognized standing with a minimum 80% standing with demonstrated research capabilities.
  - In order to be admitted to PhD candidacy, applicants must have demonstrated research capabilities. For this reason, should graduates with a Master's degree obtained without producing a research thesis desire to enter the PhD program, they must satisfy the Department that they are able to carry out independent research.

- Application materials
  - Résumé
  - Supplementary information form
• Transcript(s)

• References
  o Number of references: 3
  o Type of references: at least 2 academic.

• English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  o Candidates must successfully complete the 2 core courses and at least 1 more graduate course from the list of technical electives (0.50 unit weight) with an overall average of 70% (no more than 1 of the courses used for credit towards the PhD degree may be taught by the candidate’s supervisor). The actual program is decided by the student and the supervisor(s), subject to the approval of the Associate Chair for Graduate Studies.
  o Candidates admitted to the PhD program who do not possess a recent and relevant Master's degree or have transferred directly to the PhD program without a Master’s degree, are required to complete a minimum of 7 courses, at least 5 of which must be from the list of technical elective.
  o Core courses:
    ▪ NANO 701 Fundamentals of Nanotechnology
    ▪ NANO 702 Nanotechnology Tools
  o Core courses are designed to provide the base knowledge and skill set required to prepare students for more specialized courses and to conduct interdisciplinary nanoscale research.
  o Students who have completed their Bachelor of Applied Science (BASc) or MASc degree in Nanotechnology Engineering at the University of Waterloo will not be required to take the 2 core courses. Instead, they can choose all graduate courses from the list of technical electives.
  o Technical elective courses:
    ▪ (a) Micro/nano Instruments and Devices
      • BIOL 642 Current topics in Biotechnology
      • CHEM 750T17 Surface Science and Nanotechnology
      • CHEM 750TXX Nanostructured Materials and Analysis
      • CHEM 724 Chemical Instrumentation
      • ME 770 Topics in Heat and Fluid Flow: Micro- and Nano- fluidics
      • ME 738 Topics in Materials Science: Materials for NEMS and MEMS
      • ME 780 Topics in Mechatronics: MEMS Design and Analysis
      • SYDE 682 Advanced MEMS Physics, Design and Fabrication
• SYDE 750 Modeling, Simulation and Design of MEMS
  (b) Nanoelectronics Design and Fabrication
    • CHEM 750T11 Bioelectronics
    • CHEM 750T19 Carbon Nanotube Electronics
    • ECE 631 Microelectronic Processing Technology
    • ECE 632 Photovoltaic Energy Conversion
    • ECE 636 Analog MOS and Bipolar Integrated Circuits
    • ECE 637 Design of VLSI MOS Integrated Circuits
    • ECE 639 Characteristics & Applications of Amorphous Silicon
    • ECE 672 Optoelectronic Devices
    • ECE 730T13 Topics in Solid State Devices: Nanoelectronics
    • ECE 730T17 Topics in Solid State Devices: Physics and Modeling of Semiconductor Devices
    • ECE 730T18 Topics in Solid State Devices: Organic Electronics
    • ECE 730T19 Topics in Solid State Devices: Magnetism and Spintronics
    • ECE 730T20 Topics in Solid State Devices: Physics of Nanodevices
    • ECE 730T24 Topics in Solid State Devices: Fabrication in the nanoscale: principles, technology and applications
    • ECE 770T11 Topics in Antenna and Microwave Theory: Quantum Info Processing Devices
    • ECE 770T13 Topics in Antenna and Microwave Theory: Quantum Information Devices
    • ECE 770T14 Topics in Antenna and Microwave Theory: Quantum Electronics & Photonics
    • ME 595 Introduction to MEMS Fabrication
    • ME 596 Topics in Nanotechnology: Introduction to Fabrication & Characterization of Nano-structures
    • PHYS 713 Molecular Physics
    • PHYS 731 Solid State Physics
    • PHYS 747 Optical Electronics
  (c) Nano-biosystems
    • BIOL 608 Advanced Molecular Genetics
    • BIOL 614 Bioinformatics Tools and Techniques
    • BIOL 629 Cell Growth and Differentiation
    • BIOL 642 Current Topics in Biotechnology
    • BIOL 670 Photobiology
    • BIOL 678 Current topics in Neurophysiology
    • CHE 562 Advanced Bioprocess Engineering
• CHE 660 Principles of Biochemical Engineering
• CHE 661 Advances in Biochemical Engineering
• CHE 760 Special Topics in Biochemical Engineering
• CHE 765 Research Topics in Biochemical Engineering
• CHEM 730 Proteins and Nucleic Acids
• CHEM 731T02 Physical Biochemistry
• CHEM 737 Enzymes
• PHYS 751 Cellular Biophysics
• PHYS 752 Molecular Biophysics

  (d) Nanomaterials
  • CHE 541 Introduction to Polymer Science and Properties
  • CHE 542 Polymerization and Polymer Properties
  • CHE 612 Interfacial Phenomena
  • CHE 622 Statistics in Engineering
  • CHE 640 Principles of Polymer Science (Cross-listed with CHEM 770)
  • CHE 641 Physical Properties of Polymers (Cross-listed with CHEM 771)
  • CHE 740 Special Topics in Polymer Science and Engineering
  • CHE 750 Special Topics in Materials Science: Thin Film Fabrications & Mechanical Properties
  • CHE 755 Research Topics in Electrochemical Engineering, Interfacial Engineering & Material Science
  • CHE 745 Research Topics in Polymer Science and Engineering
  • CHEM 710T12 Structure and Function of Supramolecular Materials
  • CHEM 710T15 Advanced Solid State Chemistry: Ion, Electron and Molecular Transport
  • CHEM 710TXX Nanostructured Materials and Integrative Chemistry
  • CHEM 713 Chemistry of Inorganic Solid State Materials
  • CHEM 750T17 Surface Science and Nanotechnology
  • ME 632 Experimental Methods in Materials Engineering
  • ME 738 Topics in Materials Science: Materials for NEMS and MEMS
  • ME 738 Topics in Materials Science: Nanostructured and Amorphous Materials
  • ME 738T8 Topics in Materials Science: Introductory and Advanced Nanomechanics
  • PHYS 701 Quantum Mechanics
  • PHYS 704 Statistical Physics
  • PHYS 706 Electromagnetic Theory
  • PHYS 773 Special Topics

• Graduate Safety Milestone
• The Graduate Safety Milestone must be completed by the end of the student’s second registered term.

• PhD Research Seminar
  o This seminar is a forum for student presentation of research results or proposals. Invited speakers from academia and industry will also present results of research from time to time. The range of topics that will be addressed in the seminar crosses all areas of research in the collaborative program. Each student is required to present at least 1 research seminar. To receive credit, students are expected to attend at least 8 seminars other than their own before completing their program.

• PhD Comprehensive Examination
  o The thesis topic is decided by the student and supervisor(s), in consultation with an Advisory Committee. The proposed research program is also examined during the Comprehensive Examination.
  o The Comprehensive Examination should be conducted within about one year, but in any case not later than sixteen months, after the student has been admitted to the PhD program. In preparation for this examination candidates will submit a written research proposal of between 2,000 and 4,000 words describing their thesis problem and outlining the proposed method of attack. This proposal must be circulated to the members of the Comprehensive Examination Committee not less than two weeks before the examination. The Comprehensive Examination Committee, on the advice of the candidate’s supervisor(s), should examine:
    ▪ The adequacy of the course of study being undertaken.
    ▪ The student’s performance during the first year both in the coursework and in the research studies.
    ▪ The proposal for research program as presented by the student.
    ▪ The adequacy of the student’s technical background in related areas of knowledge.
  o The main decision to be reached is whether the candidate should proceed with the proposed study or change the emphasis in the research work. Advice about taking additional graduate courses may also be given.

• PhD Thesis
  o This degree is awarded after candidates have satisfied the Examining Committee that their thesis is a substantial original contribution to knowledge and have also demonstrated a high degree of competence in areas of knowledge related to their specialization.
  o Regulations governing the submission and examination of the PhD thesis are found in the Minimum Requirements for the PhD Degree section of the Graduate Studies Academic Calendar.
The Examining Committee consists of the supervisor(s) and four other members nominated by the supervisor(s) and is approved by the Faculty Graduate Studies Committee. One of the committee members is appointed from outside the University, another from outside the Department (often from Mathematics or Physics).

[Department of Mechanical and Mechatronics Engineering website](#)

[Waterloo Institute for Nanotechnology website](#)
The University of Waterloo offers the first MASc and PhD programs in Nanotechnology of its kind in Canada. The interdisciplinary research programs, jointly offered by three departments in the Faculty of Science and four in the Faculty of Engineering, provide students with a stimulating educational environment that spans from basic research through to application. The goal of the collaborative programs is to allow students to gain perspectives on nanotechnology from a wide community of scholars within and outside their disciplines in both course and thesis work.

The MASc degree collaborative program provides a strong foundation in the emerging areas of nano-science or nano-engineering in preparation for the workforce or for further graduate study and research leading to a doctoral degree. Four key areas of research strengths have been identified: nanomaterials, nano-electronics design and fabrication, nano-instruments and devices, and nano-biosystems. The objective of the PhD program is to prepare students for careers in academia, industrial R & D and government research labs. Students from Science and Engineering will work side-by-side in world class laboratory facilities namely, the Giga-to-Nano Electronics Lab (G2N), Waterloo Advanced Technology Lab (WatLAB) and the new 225,000 gross sq. ft. Nano-Quantum Center expected to be completed in early 2011.

There are nearly 50 faculty members involved in nanotechnology research at the university with many who are internationally renowned leaders in their fields. Among them are seven Canada Research Chairs and two NSERC Industrial Research Chairs.

Admission requirements are the same as home department programs. The home department in which the applicant intends to pursue graduate study must approve the application. Interested students should apply directly to one of the following departments via the regular university application process:

Biology
Chemical Engineering
Chemistry
Electrical and Computer Engineering
Mechanical and Mechatronics Engineering
Physics and Astronomy
Systems Design Engineering

Admission Requirements

Admission requirements are the same as those for MASc and PhD in Mechanical and Mechatronics Engineering. Please refer to the following web site:

http://www.mme.uwaterloo.ca/grad/prospective.html#admission
• Students must fulfill the minimum requirements of their home department including any thesis proposal and research seminar milestones specific to their department. It is possible that some students may need to take more courses than are prescribed by the home program requirements in order to meet the specific course requirements of the nanotechnology program.

• A complete statement regarding subject and content of this examination is given in the Engineering Graduate Studies Manual.

• Technical Electives
  Approved technical elective courses (pdf)

• Faculty Advisors/Thesis Supervisors
  Current listing of thesis supervisors and their home departments can be found at the bottom of the page at the following link: http://www.mme.uwaterloo.ca/grad/Nano.php

• For more information, please contact:
  Jian Zou
  Email: jzou@uwaterloo.ca
  (519) 888-4567 ext. 32019
Doctor of Philosophy (PhD) in Mechanical and Mechatronics Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Automation and Controls
- Fluid Mechanics
- Materials Engineering and Processing
- Solid-Body Mechanics and Mechanical Design
- Thermal Engineering

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Doctoral
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - A thesis-based Master's degree from a university of recognized standing with a minimum 80% standing with demonstrated research capabilities.
  - In order to be admitted to PhD candidacy, applicants must have demonstrated research capabilities. For this reason, should graduates with a Master's degree obtained without...
producing a research thesis desire to enter the PhD program, they must satisfy the Department that they are able to carry out independent research.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: at least 2 academic.

- English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

- Graduate Academic Integrity Module (Graduate AIM)

- Courses
  - Candidates must successfully complete at least 3 graduate courses at the 600 or 700 level (0.50 unit weight) with an overall average of 70% (no more than 1 of the courses used for credit towards the PhD degree may be taught by the candidate's supervisor). The actual program is decided by the student and the supervisor(s), subject to the approval of the Associate Chair for Graduate Studies.
  - Candidates admitted to the PhD program who do not possess a recent and relevant Master's degree or have transferred directly to the PhD program without a Master's degree, are required to complete a minimum of 7 courses, at least 5 of which must be at the 600 or 700 levels (0.50 unit weight).

- Graduate Safety Milestone
  - The Graduate Safety Milestone must be completed by the end of the student's second registered term.

- PhD Comprehensive Examination
  - The thesis topic is decided by the student and supervisor(s), in consultation with an Advisory Committee. The proposed research program is also examined during the Comprehensive Examination.
  - The Comprehensive Examination should be conducted within about one year, but in any case not later than sixteen months, after the student has been admitted to the PhD program. In preparation for this examination candidates will submit a written research proposal of between 2,000 and 4,000 words describing their thesis problem and outlining the proposed method of attack. This proposal must be circulated to the
members of the Comprehensive Examination Committee not less than two weeks before the examination. The Comprehensive Examination Committee, on the advice of the candidate's supervisor(s), should examine:

- The adequacy of the course of study being undertaken.
- The student's performance during the first year both in the coursework and in the research studies.
- The proposal for research program as presented by the student.
- The adequacy of the student's technical background in related areas of knowledge.

- The main decision to be reached is whether the candidate should proceed with the proposed study or change the emphasis in the research work. Advice about taking additional graduate courses may also be given.

• PhD Thesis

- This degree is awarded after candidates have satisfied the Examining Committee that their thesis is a substantial original contribution to knowledge and have also demonstrated a high degree of competence in areas of knowledge related to their specialization.
- Regulations governing the submission and examination of the PhD thesis are found in the Minimum Requirements for the PhD Degree section of the Graduate Studies Academic Calendar.
- The Examining Committee consists of the supervisor(s) and four other members nominated by the supervisor(s) and is approved by the Faculty Graduate Studies Committee. One of the committee members is appointed from outside the University, another from outside the Department.
Admission requirements for the Doctor of Philosophy (PhD) degree in Mechanical and Mechatronics Engineering are normally:

- Three letters of reference, from professors and/or employers (minimum two academic)
- Proof of competency in English (if applicable). A score of at least 550 is required in the Test of English as a Foreign Language (TOEFL), along with a minimum score of 4.0 in the Test of Written English (TWE). A score of at least 213 is required on the computer version of the TOEFL. See the English Language Proficiency page for other acceptable tests of English.
- Additional information is available on the Mechanical and Mechatronics Engineering website.
- The student's program is also assessed formally by the Examination Committee at the time of the Comprehensive Examination as described below.
- The requirements for the PhD degree are as follows:
  - Satisfactory performance in a Comprehensive Examination
  - Submission and defense of a thesis, embodying the results of original research
  - A complete statement regarding subject and content of this examination is given in the Engineering Graduate Studies Manual.
  - (often from Mathematics or Physics)
Graduate Diploma (GDip) in Design Engineering (MEng)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Delivery mode(s)
  - On-campus

- Program type
  - Diploma

- Study option(s)
  - Coursework

Admission requirements

- Students in the Master of Engineering (MEng) in Mechanical and Mechatronics Engineering program may complete the requirements for the GDip in Design Engineering in conjunction with their MEng requirements.

Diploma requirements

- Courses
  - Students must complete the following courses:
    - Mandatory courses:
      - ME 680 Advanced Design Engineering
      - ME 681 Advanced Design Engineering - Design Project 1
      - ME 682 Advanced Design Engineering - Design Project 2
    - Specific courses: 1 from the following list:
      - ME 538 Welding Design, Fabrication and Quality Control
      - ME 555 Computer-Aided Design
      - ME 559 Finite Element Methods
      - ME 561 Fluid Power Control Systems
      - ME 566 Computational Fluid Dynamics for Engineering Design
  - General courses: 4 additional Faculty of Engineering graduate courses (subject to the approval of the Department).
  - All courses are 600 and 700 level courses and students are not allowed to take more than 2 500 level courses (courses open to both undergraduates and graduates) out of their 8 required courses.
Requirements for the MEng include the completion of eight graduate level courses as specified below for each diploma area: Design Engineering, Fire Safety, Green Energy.

Fire Safety

Graduate Diploma requirements for Fire Safety:

<table>
<thead>
<tr>
<th>Mandatory courses:</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME 671 Fundamentals of Fire Dynamics</td>
</tr>
<tr>
<td>ME 672 Advanced Fire Dynamics</td>
</tr>
<tr>
<td>ME 673 Fire Modeling</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specific courses: 5 from the following list</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIVE 601 Engineering Risk and Reliability</td>
</tr>
<tr>
<td>ME 720 Special Topics in Solid Mechanics: Fire Resistance</td>
</tr>
<tr>
<td>ME 760 Special Topics in Thermal Engineering: Industrial Fire and Explosion Safety</td>
</tr>
<tr>
<td>ME 765 Special Topics in Fluid Mechanics: Advanced Concepts in Design for Fire Safety</td>
</tr>
<tr>
<td>ME 765 Special Topics in Fluid Mechanics: Smoke Movement</td>
</tr>
<tr>
<td>ME 765 Special Topics in Fluid Mechanics: Human Behaviour in Fires</td>
</tr>
<tr>
<td>ME 770 Special Topics in Numerical Methods, Fluid Flow and Heat Transfer: Experimental Design, Measurement and Data Validation</td>
</tr>
<tr>
<td>ME 770 Special Topics in Numerical Methods, Fluid Flow and Heat Transfer: Fire Testing</td>
</tr>
</tbody>
</table>
Graduate Diploma requirements for Green Energy:

<table>
<thead>
<tr>
<th>mandatory courses:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ME 659</strong></td>
</tr>
<tr>
<td>Energy and Environment</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>specific courses: 3 from the following list</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ME 738</strong></td>
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<tr>
<td><strong>ME 751</strong></td>
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<td><strong>ME 760</strong></td>
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<td><strong>ME 760</strong></td>
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<tr>
<td><strong>ME 760</strong></td>
</tr>
<tr>
<td><strong>ME 765</strong></td>
</tr>
</tbody>
</table>

| general courses: 4 additional Faculty of Engineering graduate courses (subject to the approval of the department) |
Graduate Diploma (GDip) in Fire Safety (MEng)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Delivery mode(s)
  - On-campus

- Program type
  - Diploma

- Study option(s)
  - Coursework

Admission requirements

- Students in the Master of Engineering (MEng) in Mechanical and Mechatronics Engineering program may complete the requirements for the GDip in Fire Safety in conjunction with their MEng requirements.

Diploma requirements

- Courses
  - Students must complete the following courses:
    - Mandatory courses:
      - ME 671 Fundamental Fire Dynamics
      - ME 672 Advanced Fire Dynamics
      - ME 673 Fire Modeling
    - Specific courses: 3 from the following list:
      - ME 720 Special Topics in Solid Mechanics: Fire Resistance
      - ME 765 Special Topics in Fluid Mechanics: Advanced Concepts in Design for Fire Safety 1
      - ME 765 Special Topics in Fluid Mechanics: Advanced Concepts in Design for Fire Safety 2
      - ME 770 Special Topics in Numerical Methods, Fluid Flow and Heat Transfer: Fire Risk Analysis or CIVE 601 Engineering Risk and Reliability
      - ME 770 Special Topics in Numerical Methods, Fluid Flow and Heat Transfer: Fire Testing
- General courses: 2 additional Faculty of Engineering graduate courses (subject to the approval of the Department).
- All courses are 600 and 700 level courses and students are not allowed to take more than 2 500 level courses (courses open to both undergraduates and graduates) out of their 8 required courses.

Department of Mechanical and Mechatronics Engineering website
Requirements for the MEng include the completion of eight graduate level courses as specified below for each diploma area: Design Engineering, Fire Safety, Green Energy.

Design Engineering

Graduate Diploma requirements for Design Engineering:

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- Green Energy

Graduate Diploma requirements for Green Energy:

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<td><strong>ME 765</strong></td>
</tr>
</tbody>
</table>

General courses: 4 additional Faculty of Engineering graduate courses (subject to the approval of the department)
Graduate Diploma (GDip) in Green Energy (MEng)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Delivery mode(s)
  - On-campus

- Program type
  - Diploma

- Study option(s)
  - Coursework

Admission requirements

- Students in the Master of Engineering (MEng) in Mechanical and Mechatronics Engineering program may complete the requirements for the GDip in Green Energy in conjunction with their MEng requirements.

Diploma requirements

- Courses
  - Students must complete the following courses:
  - Mandatory courses:
    - ME 659 Energy and Environment
  - Specific courses: 3 from the following list:
    - ME 738 Special Topics in Materials: Hydrogen Storage Materials
    - ME 751 Fuel Cell Technology
    - ME 753 Solar Energy
    - ME 760 Special Topics in Thermal Engineering: Low Energy Building Systems
    - ME 760 Special Topics in Thermal Engineering: Building Energy Performance
    - ME 760 Special Topics in Thermal Engineering: Air Pollution and Greenhouse Gases
    - ME 765 Special Topics in Fluid Mechanics: Wind Energy
  - General courses: 4 additional Faculty of Engineering graduate courses (subject to the approval of the Department).
- All courses are 600 and 700 level courses and students are not allowed to take more than 2 500 level courses (courses open to both undergraduates and graduates) out of their 8 required courses.

[Department of Mechanical and Mechatronics Engineering website](#)
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- Requirements for the MEng include the completion of eight graduate level courses as specified below for each diploma area: Design Engineering, Fire Safety, Green Energy.

- Design Engineering

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- Fire Safety

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<td><strong>ME 770</strong></td>
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<td><strong>ME 770</strong></td>
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</tbody>
</table>
Graduate Diploma (GDip) in Green Energy

Students are responsible for reviewing the [General Information and Regulations section of the Graduate Studies Academic Calendar](#).  

The GDip in Green Energy program uses a state-of-the-art interactive instruction facility called the Live-Link. This remote learning environment is enabled through the use of smart boards and multi-point interactive video conferencing.

The Live-Link technology provides an immersive, real-time experience where students seamlessly participate with the instructor and others in the class as if they were in the same location.

If students miss a class, they will have the opportunity to watch a recorded session of the class and email questions to the instructor.

When using the E5 Live System the minimum requirements to ensure the quality of the experience are:

- Up to date computer or laptop with 1GB video card and current drivers.
- Wired network connection with a minimum 1 Mbps to 2 Mbps upload speed.
- Web camera, microphone, speakers or headphones.
- Microsoft Windows OS or current Mac OS (Linux is not supported at this time).

Program information

- **Admit term(s)**
  - Fall
  - Winter
  - Spring

- **Delivery mode(s)**
  - Online

- **Length of program**
  - 1 mandatory course and 3 elective courses must be completed within two years (six terms).

- **Program type**
  - Diploma

- **Registration option(s)**
  - Full-time
• Part-time

• Study option(s)
  o Coursework

Admission requirements

• Minimum requirements
  o Four-year Bachelor’s degree in a related area of study, with an overall average of 75% in the last two years.

• Application materials
  o Résumé
  o Transcript(s)

• References
  o Number of references: 2
  o Type of references: 1 must be academic.

• English Language Proficiency Certification (ELPC) (if applicable)

Diploma requirements

• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  o The GDip program is completed by taking 4 graduate level courses and without pursuing a formal graduate studies degree program. Students can study part-time, taking 1 course per term, or full-time, taking 2 courses per term. 1 mandatory course and 3 elective courses must be completed within two years (six terms).
  o Students must complete the following courses:
    o Mandatory course:
      ▪ ME 659 Energy and Environment
    o Choose 3 electives from the following list of courses:
      ▪ ME 751 Fuel Cell Technology
      ▪ ME 753 Solar Energy
      ▪ ME 760 Special Topics in Thermal Energy: Building Energy Performance
      ▪ ME 760 Special Topics in Thermal Energy: Low Energy Building Systems
      ▪ ME 760 Special Topics in Thermal Energy: Air Pollution and Greenhouse Gases
      ▪ ME 765 Special Topics in Fluid Mechanics: Wind Energy

Department of Mechanical and Mechatronics Engineering website
The Graduate Diploma (GDip) in Green Energy is the first program of its kind in Canada and provides professional development for working engineers through live online learning. The courses will enhance a participant’s technical knowledge and training in green energy systems, such as bioenergy, fuel cells, pollution management, solar energy, wind energy, and sustainable buildings.

Canada is a highly innovative environment for green energy and you can upgrade your engineering skills in this high demand sector.

Online learning provides the flexibility to join class from work or home through an internet connection. Students can interact live online with a webcam and microphone.

Before an applicant is to be considered for the GDip in Green Energy program they must have the following:

- Applicants whose first language is not English must complete an English language proficiency exam.

The course schedule for the current and upcoming terms are now available online. Search the "Course Schedules" for Graduate Studies programs for courses at the 600 and 700 levels.

If you have any questions or concerns about the GDip in Green Energy, send them to greendiploma@uwaterloo.ca.
Master of Applied Science (MASc) in Mechanical and Mechatronics Engineering - Nanotechnology

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Master’s
  - Collaborative
  - Research

- Registration option(s)
  - Full-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - An honours Bachelor's degree (or equivalent) in an acceptable discipline from a university of recognized standing, with at least a 75% standing.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 2
Type of references: professors

- **English Language Proficiency Certification (ELPC)** (if applicable)

### Degree requirements

The MASc program emphasizes high level independent research by candidates. The topic of the thesis and the choice of courses are decided by the student and their supervisor(s). Each student's program is subject to the approval of the Associate Chair for Graduate Studies. Candidates will participate in a research program generally involving either theory or experimentation, or both.

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete 4 one-term (0.50 unit weight) graduate level courses (or courses acceptable for graduate credit). A maximum of 1 500-level course may be counted for credit.
  - Core courses:
    - NANO 701 Fundamentals of Nanotechnology
    - NANO 702 Nanotechnology Tools
  - Core courses are designed to provide the base knowledge and skill set required to prepare students for more specialized courses and to conduct interdisciplinary nanoscale research.
  - Students who have completed their Bachelor of Applied Science (BASc) degree in Nanotechnology Engineering at the University of Waterloo will not be required to take the 2 core courses. Instead, they can choose all graduate courses from the list of technical electives.
  - Technical elective courses:
    - (a) Micro/nano Instruments and Devices
      - BIOL 642 Current topics in Biotechnology
      - CHEM 750T17 Surface Science and Nanotechnology
      - CHEM 750TX X Nanostructured Materials and Analysis
      - CHEM 724 Chemical Instrumentation
      - ME 770 Topics in Heat and Fluid Flow: Micro- and Nano- fluidics
      - ME 738 Topics in Materials Science: Materials for NEMS and MEMS
      - ME 780 Topics in Mechatronics: MEMS Design and Analysis
      - SYDE 682 Advanced MEMS Physics, Design and Fabrication
      - SYDE 750 Modeling, Simulation and Design of MEMS
    - (b) Nanoelectronics Design and Fabrication
      - CHEM 750T11 Bioelectronics
      - CHEM 750T19 Carbon Nanotube Electronics
      - ECE 631 Microelectronic Processing Technology
• ECE 632 Photovoltaic Energy Conversion
• ECE 636 Analog MOS and Bipolar Integrated Circuits
• ECE 637 Design of VLSI MOS Integrated Circuits
• ECE 639 Characteristics & Applications of Amorphous Silicon
• ECE 672 Optoelectronic Devices
• ECE 730T13 Topics in Solid State Devices: Nanoelectronics
• ECE 730T17 Topics in Solid State Devices: Physics and Modeling of Semiconductor Devices
• ECE 730T18 Topics in Solid State Devices: Organic Electronics
• ECE 730T19 Topics in Solid State Devices: Magnetism and Spintronics
• ECE 730T20 Topics in Solid State Devices: Physics of Nanodevices
• ECE 730T24 Topics in Solid State Devices: Fabrication in the nanoscale: principles, technology and applications
• ECE 770T11 Topics in Antenna and Microwave Theory: Quantum Info Processing Devices
• ECE 770T13 Topics in Antenna and Microwave Theory: Quantum Information Devices
• ECE 770T14 Topics in Antenna and Microwave Theory: Quantum Electronics & Photonics
• ME 595 Introduction to MEMS Fabrication
• ME 596 Topics in Nanotechnology: Introduction to Fabrication & Characterization of Nano-structures
• PHYS 713 Molecular Physics
• PHYS 731 Solid State Physics
• PHYS 747 Optical Electronics

(c) Nano-biosystems
• BIOL 608 Advanced Molecular Genetics
• BIOL 614 Bioinformatics Tools and Techniques
• BIOL 629 Cell Growth and Differentiation
• BIOL 642 Current Topics in Biotechnology
• BIOL 670 Photobiology
• BIOL 678 Current topics in Neurophysiology
• CHE 562 Advanced Bioprocess Engineering
• CHE 660 Principles of Biochemical Engineering
• CHE 661 Advances in Biochemical Engineering
• CHE 760 Special Topics in Biochemical Engineering
• CHE 765 Research Topics in Biochemical Engineering
• CHEM 730 Proteins and Nucleic Acids
• CHEM 731T02 Physical Biochemistry  
• CHEM 737 Enzymes  
• PHYS 751 Cellular Biophysics  
• PHYS 752 Molecular Biophysics  
  ▪ (d) Nanomaterials  
    • CHE 541 Introduction to Polymer Science and Properties  
    • CHE 542 Polymerization and Polymer Properties  
    • CHE 612 Interfacial Phenomena  
    • CHE 622 Statistics in Engineering  
    • CHE 640 Principles of Polymer Science (Cross-listed with CHEM 770)  
    • CHE 641 Physical Properties of Polymers (Cross-listed with CHEM 771)  
    • CHE 740 Special Topics in Polymer Science and Engineering  
    • CHE 750 Special Topics in Materials Science: Thin Film Fabrications & Mechanical Properties  
    • CHE 755 Research Topics in Electrochemical Engineering, Interfacial Engineering & Material Science  
    • CHE 745 Research Topics in Polymer Science and Engineering  
    • CHEM 710T12 Structure and Function of Supramolecular Materials  
    • CHEM 710T15 Advanced Solid State Chemistry: Ion, Electron and Molecular Transport  
    • CHEM 710TXX Nanostructured Materials and Integrative Chemistry  
    • CHEM 713 Chemistry of Inorganic Solid State Materials  
    • CHEM 750T17 Surface Science and Nanotechnology  
    • ME 632 Experimental Methods in Materials Engineering  
    • ME 738 Topics in Materials Science: Materials for NEMS and MEMS  
    • ME 738 Topics in Materials Science: Nanostructured and Amorphous Materials  
    • ME 738T8 Topics in Materials Science: Introductory and Advanced Nanomechanics  
    • PHYS 701 Quantum Mechanics  
    • PHYS 704 Statistical Physics  
    • PHYS 706 Electromagnetic Theory  
    • PHYS 773 Special Topics  
  □ Additional Faculty regulations concerning Master's degree requirements are:  
    ▪ At least two-thirds of the courses used for credit in a candidate's program must be taken from the 600 and 700 series.  
    ▪ No more than half of the courses used for credit may be taught by the candidate's supervisor.  
    ▪ The candidate must obtain a pass in all courses credited to their program, with a minimum overall average of 70% (a grade of less than 65% in any course counts as a failure).
At least half of the courses used for credit must normally be Faculty of Engineering courses.

- **Graduate Safety Milestone**
  - The Graduate Safety Milestone must be completed by the end of the student's second registered term.

- **Nanotechnology Seminar**
  - This seminar is a forum for student presentation of research results or proposals. Invited speakers from academia and industry will also present results of research from time to time. The range of topics that will be addressed in the seminar crosses all areas of research in the collaborative program. Each student is required to present at least 1 research seminar. To receive credit, students are expected to attend at least 8 seminars other than their own before completing their program.

- **Master's Thesis**
  - Candidates are requested to give advance notice of their intention to submit a thesis approximately three months prior to submission. Two assessors will then be appointed to aid each candidate's supervisor(s) in evaluating the thesis. Normally, the assessors will be members of the Mechanical and Mechatronics Engineering Department, one being external to the supervisor's research group.

[Department of Mechanical and Mechatronics Engineering website](#)
[Waterloo Institute for Nanotechnology website](#)
The University of Waterloo offers the first MASc and PhD programs in Nanotechnology of its kind in Canada. The interdisciplinary research programs, jointly offered by three departments in the Faculty of Science and four in the Faculty of Engineering, provide students with a stimulating educational environment that spans from basic research through to application. The goal of the collaborative programs is to allow students to gain perspectives on nanotechnology from a wide community of scholars within and outside their disciplines in both course and thesis work.

The MASc degree collaborative program provides a strong foundation in the emerging areas of nano-science or nano-engineering in preparation for the workforce or for further graduate study and research leading to a doctoral degree. Four key areas of research strengths have been identified: nanomaterials, nano-electronics design and fabrication, nano-instruments and devices, and nano-biosystems. The objective of the PhD program is to prepare students for careers in academia, industrial R & D and government research labs. Students from Science and Engineering will work side-by-side in world class laboratory facilities namely, the Giga-to-Nano Electronics Lab (G2N), Waterloo Advanced Technology Lab (WatLAB) and the new 225,000 gross sq. ft. Nano-Quantum Center expected to be completed in early 2011.

There are nearly 50 faculty members involved in nanotechnology research at the university with many who are internationally renowned leaders in their fields. Among them are seven Canada Research Chairs and two NSERC Industrial Research Chairs.

Admission requirements are the same as home department programs. The home department in which the applicant intends to pursue graduate study must approve the application. Interested students should apply directly to one of the following departments via the regular university application process:

- Biology
- Chemical Engineering
- Chemistry
- Electrical and Computer Engineering
- Mechanical and Mechatronics Engineering
- Physics and Astronomy
- Systems Design Engineering

Admission Requirements

Admission requirements are the same as those for MASc and PhD in Mechanical and Mechatronics Engineering. Please refer to the following web site:

http://www.mme.uwaterloo.ca/grad/prospective.html#admission
• Students must fulfill the minimum requirements of their home department including any thesis proposal and research seminar milestones specific to their department. It is possible that some students may need to take more courses than are prescribed by the home program requirements in order to meet the specific course requirements of the nanotechnology program.

• Generally, students are required to take two core courses and complete the Nanotechnology seminar. All core courses will have written examinations.

• Technical Electives
  Approved technical elective courses (pdf)

• Faculty Advisors/Thesis Supervisors
  Current listing of thesis supervisors and their home departments can be found at the bottom of the page at the following link: http://www.mme.uwaterloo.ca/grad/Nano.php

• For more information, please contact:
  Connie Slaughter
  Email: connie.slaughter@uwaterloo.ca
  (519) 888-4567 ext. 33385
Master of Applied Science (MASc) in Mechanical and Mechatronics Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Automation and Controls
- Fluid Mechanics
- Materials Engineering and Processing
- Solid-Body Mechanics and Mechanical Design
- Thermal Engineering

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Master’s
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - An honours Bachelor's degree (or equivalent) in an acceptable discipline from a university of recognized standing, with at least a 75% standing.

- Application materials
Résumé
Supplementary information form
Transcript(s)

- References
  - Number of references: 2
  - Type of references: professors

- English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

The MASc program emphasizes high level independent research by candidates. The topic of the thesis and the choice of courses are decided by the student and their supervisor(s). Each student's program is subject to the approval of the Associate Chair for Graduate Studies. Candidates will participate in a research program generally involving either theory or experimentation, or both.

- Graduate Academic Integrity Module (Graduate AIM)

- Courses
  - Students must complete 4 one-term (0.50 unit weight) graduate level courses (or courses acceptable for graduate credit). A maximum of 1 500-level course may be counted for credit.
  - Additional Faculty regulations concerning Master's degree requirements are:
    - At least two-thirds of the courses used for credit in a candidate's program must be taken from the 600 and 700 series.
    - No more than half of the courses used for credit may be taught by the candidate's supervisor.
    - The candidate must obtain a pass in all courses credited to their program, with a minimum overall average of 70% (a grade of less than 65% in any course counts as a failure).
    - At least half of the courses used for credit must normally be Faculty of Engineering courses.

- Graduate Safety Milestone
  - The Graduate Safety Milestone must be completed by the end of the student's second registered term.

- Master's Seminar

- Master's Thesis
- Candidates are requested to give advance notice of their intention to submit a thesis approximately three months prior to submission. Two assessors will then be appointed to aid each candidate’s supervisor(s) in evaluating the thesis. Normally, the assessors will be members of the Mechanical and Mechatronics Engineering Department, one being external to the supervisor’s research group.

[Department of Mechanical and Mechatronics Engineering website](#)
Deleted content

- Candidates for the Master of Applied Science (MASc) in Mechanical and Mechatronics Engineering have the option to conduct their studies on a full-time or part-time basis.

- Admission requirements for students admitted to the Master's program are as follows:

  - Proof of competency in English (if applicable). A score of at least 550 is required in the Test of English as a Foreign Language (TOEFL), along with a minimum score of 4.0 in the Test of Written English (TWE). A score of at least 213 is required on the computer version of the TOEFL. See the English Language Proficiency page for other acceptable tests of English.

  - Additional information is available on the Mechanical and Mechatronics Engineering website.
Master of Engineering (MEng) in Mechanical and Mechatronics Engineering

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The University of Waterloo does not provide funding for MEng in Mechanical and Mechatronics Engineering students, and the candidates are expected to be self-supporting.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Master’s
  - Professional

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Coursework

Admission requirements

- Minimum requirements
  - An honours Bachelor’s degree (or equivalent) in an acceptable discipline from a university of recognized standing, with at least a 75% standing.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
Number of references: 2
Type of references: academic

- English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

- Graduate Academic Integrity Module (Graduate AIM)

Courses

- Students must complete 8 one-term (0.50 unit weight) graduate level courses (or courses acceptable for graduate credit) and a mandatory CR/NCR communications course (ESL 601R Professional Spoken English or ESL 602R Scholarly Writing in English) which is normally to be taken in the first term of the program. The communication course can be waived at the discretion of the Department. A maximum of 2 500-level courses may be counted for credit.
- At least 2 out of the 8 required courses must be taken from the following list of ME graduate core courses:
  - ME 620 Mechanics of Continua
  - ME 621 Advanced Finite Element Method
  - ME 631 Mechanical Metallurgy
  - ME 632 Experimental Methods in Materials Science
  - ME 649 Control of Machines and Processes
  - ME 640 Autonomous Mobile Robotics
  - ME 651 Heat Conduction
  - ME 652 Convective Heat Transfer
  - ME 653 Radiation Heat Transfer
  - ME 662 Advanced Fluid Mechanics
  - ME 664 Turbulent Flow
- MEEng students completing 1 of the 3 GDip program options are allowed to use their GDip mandatory courses to count toward 2 of the 8 core courses.
- MEEng students must attend at least 4 MME research seminars.
- Additional Faculty regulations concerning Master's degree requirements are:
  - The candidate must obtain a pass in all courses credited to their program, with a minimum overall average of 70% (a grade of less than 65% in any course counts as a failure).
  - At least half of the courses used for credit must normally be Faculty of Engineering courses and the other half need to be Mechanical & Mechatronics Engineering courses.

Department of Mechanical and Mechatronics Engineering website
• The Master of Engineering (MEng) may be taken by full-time students or those who wish to study on a part-time basis while remaining in full-time employment external to the University.

• Admission requirements for students admitted to the Master's program are as follows:

• Proof of competency in English (if applicable). A score of at least 550 is required in the Test of English as a Foreign Language (TOEFL), along with a minimum score of 4.0 in the Test of Written English (TWE). A score of at least 213 is required on the computer version of the TOEFL. See the English Language Proficiency page for other acceptable tests of English.

• Additional information is available on the Mechanical and Mechatronics Engineering website.
Faculty of Mathematics
Report to Senate Graduate and Research Council
March 7, 2016

Attached are revised Graduate Studies Academic Calendar (GSAC) program pages from the Faculty of Mathematics, approved by the Mathematics Faculty Graduate Studies Committee (MFGSC) on February 25, 2016. These pages have been moved to a new format as part of the GSAC project to create a new standard template for all graduate programs in the Calendar.

For the program pages listed in section 1, in addition to moving to the new template, changes are being proposed to program requirements. These changes are outlined on the covering program revision forms.

Any changes made to the program pages listed in section 2 are editorial in nature (to fit the new template) and do not represent any change to program requirements.

Please place the following motions on the agenda for the next Senate Graduate and Research Council meeting.

1) Changes to Existing Programs (for approval)

A) Department of Pure Mathematics:
   a) Doctor of Philosophy (PhD) in Pure Mathematics - addition of elective course requirement and change to the number of departmental seminars that students must participate in
   b) Master of Mathematics (MMath) in Pure Mathematics - change to admit terms (removal of spring term) and to the composition of the Departmental Graduate Committee for the thesis option
   c) Doctor of Philosophy (PhD) in Pure Mathematics - Calendar template
   d) Master of Mathematics (MMath) in Pure Mathematics - Calendar template

2) New Graduate Calendar Templates (for approval):

A) Department of Applied Mathematics:
   a) Doctor of Philosophy (PhD) in Applied Mathematics - Quantum Information
   b) Doctor of Philosophy (PhD) in Applied Mathematics – Water
   c) Doctor of Philosophy (PhD) in Applied Mathematics
   d) Master of Mathematics (MMath) in Applied Mathematics - Quantum Information
   e) Master of Mathematics (MMath) in Applied Mathematics – Water
   f) Master of Mathematics (MMath) in Applied Mathematics

B) Department of Combinatorics and Optimization:
   a) Accelerated Master’s Program in Combinatorics and Optimization
   b) Doctor of Philosophy (PhD) in Combinatorics and Optimization - Quantum Information
   c) Doctor of Philosophy (PhD) in Combinatorics and Optimization
   d) Master of Mathematics (MMath) in Combinatorics and Optimization - Co-operative Program
   e) Master of Mathematics (MMath) in Combinatorics and Optimization - Quantum Information
   f) Master of Mathematics (MMath) in Combinatorics and Optimization
C) Computational Mathematics:
   a) Master of Mathematics (MMath) in Computational Mathematics

D) Mathematics for Teachers:
   a) Master of Mathematics for Teachers (MMT)
Graduate Studies Academic Calendar
Program revision form

Use this form to:

- Propose graduate program changes that have not been previously approved, as part of the Graduate Studies Academic Calendar (GSAC) update project (Fall 2015).

Faculty: Choose an item. Mathematics
Program: Pure Mathematics Doctor of Philosophy (PhD) in Pure Mathematics
Program contact(s) (name): Nancy Maloney

Description of proposed change: Change of wording in Calendar to agree with previously approved practices.
*changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form.

Rationale for change: To agree with our previously approved practices.

<table>
<thead>
<tr>
<th>Current Graduate Studies Academic Calendar content (using the new GSAC program document):</th>
<th>Proposed Graduate Studies Academic Calendar content (keeping format of GSAC program document):</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 of the required courses must be PMATH graduate courses numbered in the 800’s and 900’s.</td>
<td>At least 3 of the 4 required courses must be PMATH graduate courses numbered in the 800’s and 900’s. If the 4th course is not a PMATH course it must be approved by the Pure Mathematics Graduate Committee.</td>
</tr>
<tr>
<td>Regular participation in at least 2 departmental seminars is expected and the student must present at least 2 talks in a department seminar.</td>
<td>Regular participation in at least 1 departmental seminar is expected and the student must present at least 2 talks in a department seminar.</td>
</tr>
<tr>
<td>The Graduate Committee offers these written exams in the spring of each year.</td>
<td>The Graduate Committee offers these written exams annually.</td>
</tr>
<tr>
<td>The Examining Committee and the area to be examined must be approved by the Graduate Committee.</td>
<td>The Examining Committee and the area to be examined must be approved by the Associate chair, graduate studies.</td>
</tr>
</tbody>
</table>

Reviewed by GSO (for GSO use only): ☐
Use this form to:

- Propose graduate program changes that have not been previously approved, as part of the Graduate Studies Academic Calendar (GSAC) update project (Fall 2015).

**Faculty**: Choose an item. Mathematics  
**Program**: Pure Mathematics Master of Mathematics (MMath) in Pure Mathematics  
**Program contact(s) (name)**: Nancy Maloney

**Description of proposed change**: Change of wording in Calendar to agree with previously approved practices.

*changes to courses and milestones also require the completion/submission of the SGRC Course/Milestone-New/Revision/Inactivation form.*

**Rationale for change**: To agree with our previously approved practices.

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<tbody>
<tr>
<td>(strikethrough content that is to be deleted)</td>
<td>(underline content that is to be added)</td>
</tr>
<tr>
<td>Admit term (s)</td>
<td>Admit term (s)</td>
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<tr>
<td>Fall</td>
<td>Fall</td>
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<tr>
<td>Winter</td>
<td>Winter</td>
</tr>
<tr>
<td>Spring</td>
<td>It will consist of the student’s supervisor and two other members of the Department.</td>
</tr>
</tbody>
</table>

Reviewed by GSO (for GSO use only): □

**Departmental approval date**: December 9, 2015

**Faculty approval date**: ________________________________

**SGRC approval date**: ________________________________

**Senate approval date (if applicable)**: ________________________________
Doctor of Philosophy (PhD) in Pure Mathematics

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Algebra and Logic
- Analysis
- Geometry and Topology
- Number Theory

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Doctoral
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - A Master's degree (or equivalent) in Mathematics with at least a 78% standing. Exceptions may be made for students with an Honours Bachelor degree who demonstrate a very high level of background preparation and research potential.
  - A one-page personal statement.

- Application materials
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: at least 2 academic.
Degree requirements

- **English Language Proficiency Certification (ELPC)** (if applicable)

**Courses**

- The program requires a minimum of 4 graduate courses with an average of at least 70% (with unit weights equal to 0.50) for those entering the PhD program with a Master's degree. At least 3 of the 4 required courses must be PMATH graduate courses numbered in the 800's and 900's. If the 4th course is not a PMATH course it must be approved by the Pure Mathematics Graduate Committee. None of the 4 required courses can be graduate courses that are jointly held with undergraduate courses or reading courses. Up to 3 course credits may be granted by the Graduate Committee for work completed towards the PhD degree at another institution provided that the relevance of the previous work to the student’s proposed program is clearly established.

- Students entering the program with a Bachelor's degree normally must also satisfy the course requirements of a Master of Mathematics (MMath) degree in addition to those of the PhD program. The number and nature of such courses shall be specified at the time of admission, or early on in the program.

**PhD Lecturing Requirement**

- Regular participation in at least 1 departmental seminar is expected and the student must present at least 2 talks in a department seminar.

**PhD Comprehensive Examination I and PhD Comprehensive Examination II**

- Satisfactory performance in 2 written comprehensive examinations is required:
  - 1 in algebra
  - 1 in analysis and topology

- The syllabus is based on the material covered in the University of Waterloo's third and fourth year undergraduate courses. The Graduate Committee offers these written exams annually. Normally students must attempt both exams within one year of their registration in the PhD program, and both exams must be successfully completed within two years.

- Satisfactory performance in the oral comprehensive examination is required. The oral comprehensive examination demonstrates an in-depth knowledge in an area chosen by the candidate and their supervisor, usually the general area in which the thesis will be written. It should be completed within two years of registration in the PhD program. At most two attempts are permitted. There must be at least two examiners, including the supervisor and another expert in the area of the exam. The Examining Committee and the area to be examined must be approved by the Associate Chair, Graduate Studies.

**PhD Thesis**

- Students must complete a thesis embodying the results of original research. This is the most important requirement! The thesis must be of a standard that warrants publication in the research literature of the field. The thesis must be acceptable to a committee approved by the
Graduate Committee consisting of the student's supervisor and four other professors; one of whom must be from another department, and one must be an independent external examiner familiar with the student's research field. The student is required to defend the thesis at an oral examination.

Department of Pure Mathematics website

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- Proof of competency in English (if applicable). A score of at least 580 (paper based), 237 (computer based), or 92-92 (Internet based) is required in the Test of English as a Foreign Language (TOEFL) and 4.0 on the TWE. See the English Language Proficiency page for other acceptable tests of English
Master of Mathematics (MMath) in Pure Mathematics

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Algebra and Logic
- Analysis
- Geometry and Topology
- Number Theory

Program information

- Admit term(s)
  - Fall
  - Winter

- Delivery mode(s)
  - On-campus

- Program type
  - Master’s
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Master’s Research Paper
  - Thesis

Admission requirements

- Minimum requirements
  - An Honours Bachelor's degree (or equivalent) in Mathematics with at least a 78% standing.

- Application materials
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: at least 2 academic.

- English Language Proficiency Certification (ELPC) (if applicable)
Degree requirements

Masters’ Research Paper option:

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - The Master’s Research Paper option requires a minimum of 6 graduate course credits with an average of at least 70% (with unit weights equal to 0.50). At least 4 courses must be PMATH courses. At least 2 of the courses must be PMATH graduate courses numbered in the 800's and 900's. At most 2 courses can be graduate courses that are jointly held with undergraduate courses. In order for a reading course to count as 1 of the 6 required courses, approval must be obtained from the Departmental Graduate Committee. A reading course consisting of work done by a student in the immediate preparation for writing the research paper would not normally be counted as 1 of the 6 required courses. The selection of courses normally requires the approval of the student's graduate advisor.

- **Master’s Research Paper**
  - The Master’s Research Paper will normally be completed in the Spring term (May - August) for students who entered the program in the previous Fall term. A typical research paper is roughly 25-30 typed pages.

Thesis option:

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - The Thesis option requires a minimum of 4 graduate course credits with an average of at least 70% (with unit weights equal to 0.50 each). At least 2 of the courses must be PMATH graduate courses numbered in the 800's and 900's. The other 2 courses can include at most 1 graduate course that is jointly held with undergraduate courses and at most 1 graduate course from outside the Pure Mathematics Department. The selection of courses normally requires the approval of the student’s graduate advisor. In order for a reading course to count as 1 of the 4 required courses, approval must be obtained from the Departmental Graduate Committee. A reading course consisting of work done by a student in the immediate preparation for writing a thesis would not normally be counted as 1 of the 4 required courses.

- **Master’s Seminar**
  - Regular participation in a departmental seminar is required.

- **Master’s Thesis**
  - The thesis must be acceptable to a committee approved by the Departmental Graduate Committee. It will consist of the student's supervisor and two other readers who will normally be faculty members at Waterloo. At least one of the two other readers must be a member of the Pure Mathematics department. The nature and length of a Master's thesis can vary greatly. However, a typical thesis is roughly 50-100 typed pages. The thesis should be a
synthesis of some research papers or monographs, and may also contain some original work. The student will be expected to give a talk on their thesis.

Department of Pure Mathematics website

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- The minimum requirements for admission to the Master of Mathematics (MMath) in Pure Mathematics (PMath) program normally include:

- Successful applicants with insufficient background may be asked to take additional courses or a qualifying year

- Proof of competency in English (if applicable). A score of at least 580 (paper based), 237 (computer based), or 92-92 (Internet based) is required in the Test of English as a Foreign Language (TOEFL) and 4.0 on the TWE. See the English Language Proficiency page for other acceptable tests of English
Doctor of Philosophy (PhD) in Applied Mathematics – Quantum Information

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Doctoral
  - Collaborative
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - Minimum grade point average: 78% or its equivalent.
  - It is absolutely essential that the application for admission into the program contain evidence of potential for performing original research. This should be provided by successful completion of a Master’s thesis in a mathematics-related discipline.
  - In some circumstances a student enrolled in the MMath program may transfer to the PhD program without completing their MMath program.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: normally from academic sources

- English Language Proficiency Certification (ELPC) (if applicable)
Degree requirements

The program of studies of a PhD student is directed by a PhD Advisory Committee consisting of the supervisor(s) and two other faculty members. This committee should be approved (by the graduate officer) within three terms of enrollment. At least one of the two other members should be from (or cross-appointed to) the Department, and one of the members should be from outside the research group of the supervisor(s).

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  
  Students must complete 4 one-term (0.50 unit) graduate courses after the Master's degree, satisfying a breadth requirement and Quantum Information core course requirement, or 8 one-term (0.50 unit) graduate courses after the Bachelor's degree, satisfying a breadth requirement and Quantum Information core course requirement. Candidates for the PhD degree must maintain a grade point average of at least 70% in their coursework. Besides the breadth and Quantum Information requirements, there are no other constraints on course selection.
  
  - Breadth requirement: all PhD students are required to take 1 Computation course, 1 Differential Equations course, and 1 Techniques course, from the following lists:
    
    - **Computation:**
      
      - AMATH 740 Numerical Analysis
      - AMATH 741 Numerical Solution of Partial Differential Equations
    
    - **Differential Equations:**
      
      - AMATH 751 Advanced Ordinary Differential Equations
      - AMATH 753 Advanced Partial Differential Equations
      - AMATH 777 Stochastic Processes in the Physical Sciences
    
    - **Techniques:**
      
      - AMATH 731 Applied Functional Analysis
      - AMATH 732 Asymptotic Analysis and Perturbation Theory
  
  - Quantum Information core course requirement: students are required to take the 2 Quantum Information core courses listed below. These interdisciplinary courses provide a strong foundation in quantum information science:
    
    - QIC 710 Quantum Information Processing
    - QIC 750 Implementation of Quantum Information Processing
  
  The completion of 2 graduate courses in Quantum Information (other than QIC 710 and QIC 750) is also required.
  
  - Students may not count more than 1 graduate course that is cross-listed with an undergraduate course for credit towards their PhD degree. This restriction applies to all 600-level AMATH courses and any cross-listed courses offered by other departments. Note: students who transfer directly into the PhD program (without completing the Master's degree) may take up to 2 cross-listed courses.
  
  - If a PhD student has taken an equivalent course during a Master's program, this can be counted (upon approval from the Graduate Officer) towards completion of the breadth requirement but does not reduce the number of courses required.
  
  - Courses are selected in consultation with the student's supervisor. Students are encouraged to select courses that will help them develop a broad knowledge of Mathematics and its...
applications: appropriate courses are often offered by other departments in the Faculties of Mathematics, Science and Engineering.

- **PhD Comprehensive Examination**
  - During the third term of enrollment, the candidate will give a 30-minute pre-comprehensive seminar on the proposed research area, emphasizing background material. Shortly thereafter the advisory committee shall decide on the background topics that will comprise the candidate's comprehensive exam. The student will be informed of the areas of examination 3-4 months prior to the comprehensive examination.
  - The comprehensive examination is to be completed by the end of the student’s fifth term. The candidate will prepare a written research proposal (approximately 25 pages) that will be submitted to the members of the advisory committee and the examination chair (normally the graduate officer) at least two weeks prior to the comprehensive examination. The proposal should describe the research problem, together with motivation, literature review, an indication of methodology, any progress made to date, and a research plan with timeline.
  - Shortly before the comprehensive examination, the examination chair (through the graduate coordinator) will consult with the advisory committee to determine whether the committee wishes the exam to proceed and, if so, whether the committee wishes to meet to discuss the questions to be asked on background material. Each committee member will provide a typeset list of questions to the graduate coordinator four business days before the exam (about 3-5 questions, which can all be answered at a whiteboard in about 15 minutes). This list of questions will be provided to the candidate one hour prior to the start of the exam. The candidate will use this time to prepare answers, with no access to outside materials.
  - The examination will consist of a 20 minute presentation of the proposed research followed by two rounds of questions: the first on the prepared background questions, the second on the research proposal and the relevant literature. Each examiner shall question the candidate for approximately 15 minutes in each round. If there is more than one supervisor, they will share the allotted 15 minute time-slot. The comprehensive examination should normally be completed in two hours, after which the committee will consider the student’s progress to date, the proposal, and the student’s performance in the exam. They will then make one of the following assessments: pass (possibly contingent on some further action, such as completing a specific course); re-examination on background and/or proposal; or fail. Students who have not satisfactorily completed the comprehensive examination by the end of the fifth term will have their progress reviewed by the departmental graduate committee.

- **PhD Lecturing Requirement**
  - This requirement is normally met by teaching a one-term undergraduate course, usually at the first or second year level, under the supervision of a faculty member. Students will satisfy this requirement after completing the comprehensive examination and after obtaining experience as a teaching assistant. If the department is unable to provide the student with a suitable undergraduate course to teach, the requirement may be met by giving a series of lectures of an introductory nature concerning the student’s field of research.

- **PhD Quantum Information Seminar**
• Students must successfully complete a seminar milestone consisting of one Institute for Quantum Computing (IQC) seminar and one seminar on a Quantum Information (QI) topic. If appropriate, lectures given as part of the PhD Lecturing Requirement may also be used to satisfy the seminar requirement.

• PhD Thesis
  o A PhD thesis contains original results that warrant publication in the research literature. Indeed, candidates are encouraged to publish papers based on their research before submitting their theses. Moreover, the Department expects a PhD thesis to be a scholarly work that is broad in scope. As such, it should contain a discussion of the history of the research problem and an analysis of the relevant literature. For University guidelines on co-authored material in PhD theses please visit the Graduate Studies Office website; additional departmental guidelines apply.
  o The thesis must be on a topic in Quantum Information. The supervisor must be an approved Quantum Information thesis supervisor. A list of approved supervisor can be found on the Institute for Quantum Computing website.
  o The candidate shall defend the thesis in an oral examination before an Examining Committee, which shall consist of the Advisory Committee, one faculty member from outside the Department, and an external examiner familiar with the student's research field.

Department of Applied Mathematics website
Institute for Quantum Computing website

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• The minimum requirements for admission to the PhD program normally include:

• Proof of competency in English (if applicable). A score of at least 600 (250 in the computerized version and 100 on the internet-based version) is required in the Test of English as a Foreign Language (TOEFL) and 4.0 on the TWE. See the English Language Proficiency page for other acceptable tests of English.
Doctor of Philosophy (PhD) in Applied Mathematics - Water

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Doctoral
  - Collaborative
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - Minimum grade point average: 78% or its equivalent.
  - It is absolutely essential that the application for admission into the program contain evidence of potential for performing original research. This should be provided by successful completion of a Master’s thesis in a mathematics-related discipline.
  - In some circumstances a student enrolled in the MMath program may transfer to the PhD program without completing their MMath program.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: normally from academic sources

- English Language Proficiency Certification (ELPC) (if applicable)
Degree requirements

The program of studies of a PhD student is directed by a PhD Advisory Committee consisting of the supervisor(s) and two other faculty members. This committee should be approved (by the graduate officer) within three terms of enrollment. At least one of the two other members should be from (or cross-appointed to) the Department, and one of the members should be from outside the research group of the supervisor(s).

- Graduate Academic Integrity Module (Graduate AIM)

- Courses
  - Students must complete 4 one-term (0.50 unit) graduate courses after the Master's degree, satisfying a breadth requirement and Water core course requirement, or 8 one-term (0.50 unit) graduate courses after the Bachelor's degree, satisfying a breadth requirement and Water core course requirement. Candidates for the PhD degree must maintain a grade point average of at least 70% in their coursework. Besides the breadth and Water requirements, there are no other constraints on course selection.
  - Breadth requirement: all PhD students are required to take 1 Computation course, 1 Differential Equations course, and 1 Techniques course, from the following lists:
    - Computation:
      - AMATH 740 Numerical Analysis
      - AMATH 741 Numerical Solution of Partial Differential Equations
    - Differential Equations:
      - AMATH 751 Advanced Ordinary Differential Equations
      - AMATH 753 Advanced Partial Differential Equations
      - AMATH 777 Stochastic Processes in the Physical Sciences
    - Techniques:
      - AMATH 731 Applied Functional Analysis
      - AMATH 732 Asymptotic Analysis and Perturbation Theory
  - Water core course requirement: students are required to take the 2 Water core courses listed below. These core courses are designed to provide fundamental multidisciplinary knowledge and experience to complement the student’s specialist courses and water-related research:
    - WATER 601 Integrated Water Management
    - WATER 602 Integrated Water Management Project
  - Students may not count more than 1 graduate course that is cross-listed with an undergraduate course for credit towards their PhD degree. This restriction applies to all 600-level AMATH courses and any cross-listed courses offered by other departments. Note: students who transfer directly into the PhD program (without completing the Master's degree) may take up to 2 cross-listed courses.
  - If a PhD student has taken an equivalent course during a Master's program, this can be counted (upon approval from the Graduate Officer) towards completion of the breadth requirement but does not reduce the number of courses required
  - Courses are selected in consultation with the student’s supervisor. Students are encouraged to select courses that will help them develop a broad knowledge of Mathematics and its applications: appropriate courses are often offered by other departments in the Faculties of Mathematics, Science and Engineering.
• PhD Comprehensive Examination
  o During the third term of enrollment, the candidate will give a 30-minute pre-comprehensive seminar on the proposed research area, emphasizing background material. Shortly thereafter the advisory committee shall decide on the background topics that will comprise the candidate's comprehensive exam. The student will be informed of the areas of examination 3-4 months prior to the comprehensive examination.
  o The comprehensive examination is to be completed by the end of the student’s fifth term. The candidate will prepare a written research proposal (approximately 25 pages) that will be submitted to the members of the advisory committee and the examination chair (normally the graduate officer) at least two weeks prior to the comprehensive examination. The proposal should describe the research problem, together with motivation, literature review, an indication of methodology, any progress made to date, and a research plan with timeline.
  o Shortly before the comprehensive examination, the examination chair (through the graduate coordinator) will consult with the advisory committee to determine whether the committee wishes the exam to proceed and, if so, whether the committee wishes to meet to discuss the questions to be asked on background material. Each committee member will provide a typeset list of questions to the graduate coordinator four business days before the exam (about 3-5 questions, which can all be answered at a whiteboard in about 15 minutes). This list of questions will be provided to the candidate one hour prior to the start of the exam. The candidate will use this time to prepare answers, with no access to outside materials.
  o The examination will consist of a 20 minute presentation of the proposed research followed by two rounds of questions: the first on the prepared background questions, the second on the research proposal and the relevant literature. Each examiner shall question the candidate for approximately 15 minutes in each round. If there is more than one supervisor, they will share the allotted 15 minute time-slot. The comprehensive examination should normally be completed in two hours, after which the committee will consider the student’s progress to date, the proposal, and the student’s performance in the exam. They will then make one of the following assessments: pass (possibly contingent on some further action, such as completing a specific course); re-examination on background and/or proposal; or fail. Students who have not satisfactorily completed the comprehensive examination by the end of the fifth term will have their progress reviewed by the departmental graduate committee.

• PhD Lecturing Requirement
  o This requirement is normally met by teaching a one-term undergraduate course, usually at the first or second year level, under the supervision of a faculty member. Students will satisfy this requirement after completing the comprehensive examination and after obtaining experience as a teaching assistant. If the department is unable to provide the student with a suitable undergraduate course to teach, the requirement may be met by giving a series of lectures of an introductory nature concerning the student's field of research.

• PhD Thesis
  o The program of study should have a substantial focus on water. A PhD thesis contains original results that warrant publication in the research literature. Indeed, candidates are encouraged to publish papers based on their research before submitting their theses. Moreover, the Department expects a PhD thesis to be a scholarly work that is broad in scope. As such, it
should contain a discussion of the history of the research problem and an analysis of the relevant literature. For University guidelines on co-authored material in PhD theses please visit the Graduate Studies Office website; additional departmental guidelines apply.

- The candidate shall defend the thesis in an oral examination before an Examining Committee, which shall consist of the Advisory Committee, one faculty member from outside the Department, and an external examiner familiar with the student’s research field.

Department of Applied Mathematics website

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- The minimum requirements for admission to the PhD program normally include:

- Proof of competency in English (if applicable). A score of at least 600 (250 in the computerized version and 100 on the internet-based version) is required in the Test of English as a Foreign Language (TOEFL) and 4.0 on the TWE. See the English Language Proficiency page for other acceptable tests of English.
Doctor of Philosophy (PhD) in Applied Mathematics

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Control and Dynamical Systems
- Fluid Mechanics
- Mathematical Medicine and Biology
- Mathematical Physics
- Scientific Computing

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Doctoral
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - Minimum grade point average: 78% or its equivalent.
  - It is absolutely essential that the application for admission into the program contain evidence of potential for performing original research. This should be provided by successful completion of a Master’s thesis in a mathematics-related discipline.
  - In some circumstances a student enrolled in the MMath program (thesis) in Applied Mathematics may transfer to the PhD program without completing their MMath program.

- Application materials
  - Résumé
  - Supplementary information form
Degree requirements

The program of studies of a PhD student is directed by a PhD Advisory Committee consisting of the supervisor(s) and two other faculty members. This committee should be approved (by the graduate officer) within three terms of enrollment. At least one of the two other members should be from (or cross-appointed to) the Department, and one of the members should be from outside the research group of the supervisor(s).

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete 4 one-term (0.50 unit) graduate courses after the Master's degree, satisfying a breadth requirement, or 8 one-term (0.50 unit) graduate courses after the Bachelor's degree, satisfying a breadth requirement. Candidates for the PhD degree must maintain a grade point average of at least 70% in their coursework. Besides the breadth requirement, there are no other constraints on course selection.
  - Breadth requirement: all PhD students are required to take 1 Computation course, 1 Differential Equations course, and 1 Techniques course, from the following lists:
    - Computation:
      - AMATH 740 Numerical Analysis
      - AMATH 741 Numerical Solution of Partial Differential Equations
    - Differential Equations:
      - AMATH 751 Advanced Ordinary Differential Equations
      - AMATH 753 Advanced Partial Differential Equations
      - AMATH 777 Stochastic Processes in the Physical Sciences
    - Techniques:
      - AMATH 731 Applied Functional Analysis
      - AMATH 732 Asymptotic Analysis and Perturbation Theory
  - Students may not count more than 1 graduate course that is cross-listed with an undergraduate course for credit towards their PhD degree. This restriction applies to all 600-level AMATH courses and any cross-listed courses offered by other departments. Note: students who transfer directly into the PhD program (without completing the Master's degree) may take up to 2 cross-listed courses.
  - If a PhD student has taken an equivalent course during a Master's program, this can be counted (upon approval from the Graduate Officer) towards completion of the breadth requirement but does not reduce the number of courses required.
  - Courses are selected in consultation with the student's supervisor. Students are encouraged to select courses that will help them develop a broad knowledge of Mathematics and its applications: appropriate courses are often offered by other departments in the Faculties of Mathematics, Science and Engineering.
• **PhD Comprehensive Examination**
  - During the third term of enrollment, the candidate will give a 30-minute pre-comprehensive seminar on the proposed research area, emphasizing background material. Shortly thereafter the advisory committee shall decide on the background topics that will comprise the candidate's comprehensive exam. The student will be informed of the areas of examination 3-4 months prior to the comprehensive examination.
  - The comprehensive examination is to be completed by the end of the student’s fifth term. The candidate will prepare a written research proposal (approximately 25 pages) that will be submitted to the members of the advisory committee and the examination chair (normally the graduate officer) at least two weeks prior to the comprehensive examination. The proposal should describe the research problem, together with motivation, literature review, an indication of methodology, any progress made to date, and a research plan with timeline.
  - Shortly before the comprehensive examination, the examination chair (through the graduate coordinator) will consult with the advisory committee to determine whether the committee wishes the exam to proceed and, if so, whether the committee wishes to meet to discuss the questions to be asked on background material. Each committee member will provide a typeset list of questions to the graduate coordinator four business days before the exam (about 3-5 questions, which can all be answered at a whiteboard in about 15 minutes). This list of questions will be provided to the candidate one hour prior to the start of the exam. The candidate will use this time to prepare answers, with no access to outside materials.
  - The examination will consist of a 20 minute presentation of the proposed research followed by two rounds of questions: the first on the prepared background questions, the second on the research proposal and the relevant literature. Each examiner shall question the candidate for approximately 15 minutes in each round. If there is more than one supervisor, they will share the allotted 15 minute time-slot. The comprehensive examination should normally be completed in two hours, after which the committee will consider the student’s progress to date, the proposal, and the student’s performance in the exam. They will then make one of the following assessments: pass (possibly contingent on some further action, such as completing a specific course); re-examination on background and/or proposal; or fail. Students who have not satisfactorily completed the comprehensive examination by the end of the fifth term will have their progress reviewed by the departmental graduate committee.

• **PhD Lecturing Requirement**
  - This requirement is normally met by teaching a one-term undergraduate course, usually at the first or second year level, under the supervision of a faculty member. Students will satisfy this requirement after completing the comprehensive examination and after obtaining experience as a teaching assistant. If the department is unable to provide the student with a suitable undergraduate course to teach, the requirement may be met by giving a series of lectures of an introductory nature concerning the student’s field of research.

• **PhD Thesis**
  - A PhD thesis contains original results that warrant publication in the research literature. Indeed, candidates are encouraged to publish papers based on their research before submitting their theses. Moreover, the Department expects a PhD thesis to be a scholarly
work that is broad in scope. As such, it should contain a discussion of the history of the research problem and an analysis of the relevant literature. For University guidelines on co-authored material in PhD theses please visit the Graduate Studies Office website; additional departmental guidelines apply.

- The candidate shall defend the thesis in an oral examination before an Examining Committee, which shall consist of the Advisory Committee, one faculty member from outside the Department, and an external examiner familiar with the student's research field.

Department of Applied Mathematics website

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- The minimum requirements for admission to the PhD program normally include:

- Proof of competency in English (if applicable). A score of at least 600 (250 in the computerized version and 100 on the internet-based version) is required in the Test of English as a Foreign Language (TOEFL) and 4.0 on the TWE. See the English Language Proficiency page for other acceptable tests of English.
Master of Mathematics (MMath) in Applied Mathematics – Quantum Information

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Master's
  - Collaborative
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - An overall 78% average or its equivalent for undergraduate work.
  - A four-year Honours Bachelor degree with a specialization in Mathematics, or in Science or Engineering with a strong concentration in mathematics.
  - Students who have a strong academic record but who have some gaps in their Applied Mathematics background may be admitted subject to the requirement that they complete a selection of fourth year undergraduate courses as part of their graduate program.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: normally from academic sources.

- English Language Proficiency Certification (ELPC) (if applicable)
Degree requirements

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete 4 one-term (0.50 unit) graduate courses, satisfying a breadth requirement and Quantum Information core course requirement. Candidates for the MMath (thesis) degree must maintain a grade point average of at least 70% in their coursework. Besides the breadth and Quantum Information requirements, there are no other constraints on course selection.
  - Breadth requirement: students are required to take 1 Computation course and 1 Differential Equations or Techniques course, from the following list:
    - **Computation:**
      - AMATH 740 Numerical Analysis
      - AMATH 741 Numerical Solution of Partial Differential Equations
    - **Differential Equations:**
      - AMATH 751 Advanced Ordinary Differential Equations
      - AMATH 753 Advanced Partial Differential Equations
      - AMATH 777 Stochastic Processes in the Physical Sciences
    - **Techniques:**
      - AMATH 731 Applied Functional Analysis
      - AMATH 732 Asymptotic Analysis and Perturbation Theory
  - Quantum Information core course requirement: students are required to take the 2 Quantum Information core courses listed below. These interdisciplinary courses provide a strong foundation in quantum information science:
    - QIC 710 Quantum Information Processing
    - QIC 750 Implementation of Quantum Information Processing
  - Students may not count more than 1 graduate course that is cross-listed with an undergraduate course for credit towards their MMath (thesis) degree. This restriction applies to all 600-level AMATH courses and any cross-listed courses offered by other departments.
  - Courses are selected in consultation with the student's supervisor. Students are encouraged to select courses that will help them develop a broad knowledge of Mathematics and its applications: appropriate courses are often offered by other departments in the Faculties of Mathematics, Science and Engineering.

- **Master's Thesis**
  - The MMath thesis is a comprehensive study that contributes to the understanding of a research topic, either by relating various approaches in the literature or by developing new methods. An MMath thesis is not required to contain original results. However, it is not uncommon for students - particularly those who have had research experience as undergraduates - to obtain new results that lead to publication in the research literature. For University guidelines on co-authored material in Masters theses please visit the [Graduate Studies Office](#) website; additional [departmental guidelines](#) apply.
  - The Master's thesis is read by a committee that consists of the thesis supervisor and two other faculty members who are knowledgeable about the research area. The supervisor and at least
one of the other two committee members must be affiliated with the Department of Applied Mathematics.

- The thesis must be on a topic in Quantum Information. The supervisor must be an approved Quantum Information thesis supervisor. A list of approved supervisors can be found on the Institute for Quantum Computing website.

- The student will present their results in a thesis defence, which consists of a 20 minute presentation by the candidate, followed by detailed questioning by the committee members. The thesis should be provided to the Examining Committee at least two weeks before the defence date.

[Department of Applied Mathematics website](#)

[Institute for Quantum Computing website](#)

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- The minimum requirements for admission to the Master of Mathematics (MMath) in Applied Mathematics program normally include:

- Proof of competency in English (if applicable). A score of at least 600 (250 on the computerized version and 100 on the Internet-based version) is required in the Test of English as a Foreign Language (TOEFL) and 4.0 on the TWE. See the English Language Proficiency page for other acceptable tests of English.
Master of Mathematics (MMath) in Applied Mathematics - Water

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Master’s
  - Collaborative
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - An overall 78% average or its equivalent for undergraduate work.
  - A four-year Honours Bachelor degree with a specialization in Mathematics, or in Science or Engineering with a strong concentration in mathematics.
  - Students who have a strong academic record but who have some gaps in their Applied Mathematics background may be admitted subject to the requirement that they complete a selection of fourth year undergraduate courses as part of their graduate program.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: normally from academic sources.

- English Language Proficiency Certification (ELPC) (if applicable)
Degree requirements

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete 4 one-term (0.50 unit) graduate courses, satisfying a breadth requirement and Water core course requirement. Candidates for the MMath (thesis) degree must maintain a grade point average of at least 70% in their coursework. Besides the breadth and Water requirements, there are no other constraints on course selection.
  - Breadth requirement: students are required to take 1 Computation course and 1 Differential Equations or Techniques course, from the following list:
    - Computation:
      - AMATH 740 Numerical Analysis
      - AMATH 741 Numerical Solution of Partial Differential Equations
    - Differential Equations:
      - AMATH 751 Advanced Ordinary Differential Equations
      - AMATH 753 Advanced Partial Differential Equations
      - AMATH 777 Stochastic Processes in the Physical Sciences
    - Techniques:
      - AMATH 731 Applied Functional Analysis
      - AMATH 732 Asymptotic Analysis and Perturbation Theory
  - Water core course requirement: students are required to take the 2 Water core courses listed below. These core courses are designed to provide fundamental multidisciplinary knowledge and experience to complement the student’s specialist courses and water-related research:
    - WATER 601 Integrated Water Management
    - WATER 602 Integrated Water Management Project
  - Students may not count more than 1 graduate course that is cross-listed with an undergraduate course for credit towards their MMath (thesis) degree. This restriction applies to all 600-level AMATH courses and any cross-listed courses offered by other departments.
  - Courses are selected in consultation with the student's supervisor. Students are encouraged to select courses that will help them develop a broad knowledge of Mathematics and its applications: appropriate courses are often offered by other departments in the Faculties of Mathematics, Science and Engineering.

- **Master’s Thesis**
  - The program of study should have a substantial focus on water. The MMath thesis is a comprehensive study that contributes to the understanding of a research topic, either by relating various approaches in the literature or by developing new methods. An MMath thesis is not required to contain original results. However, it is not uncommon for students - particularly those who have had research experience as undergraduates - to obtain new results that lead to publication in the research literature.
  - The Master's thesis is read by a committee that consists of the thesis supervisor and two other faculty members who are knowledgeable about the research area. The supervisor and at least one of the other two committee members must be affiliated with the Department of Applied Mathematics.
The student will present their results in a thesis defence, which consists of a 20 minute presentation by the candidate, followed by detailed questioning by the committee members. The thesis should be provided to the examining committee at least two weeks before the defence date.

Department of Applied Mathematics website

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- The minimum requirements for admission to the Master of Mathematics (MMath) in Applied Mathematics program normally include:

- Proof of competency in English (if applicable). A score of at least 600 (250 on the computerized version and 100 on the Internet-based version) is required in the Test of English as a Foreign Language (TOEFL) and 4.0 on the TWE. See the English Language Proficiency page for other acceptable tests of English.
Master of Mathematics (MMath) in Applied Mathematics

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Control and Dynamical Systems
- Fluid Mechanics
- Mathematical Medicine and Biology
- Mathematical Physics
- Scientific Computing

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Program type
  - Master’s
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis
  - Master’s Research Paper

Admission requirements

- Minimum requirements
  - An overall 78% average or its equivalent for undergraduate work.
  - A four-year Honours Bachelor degree with a specialization in Mathematics, or in Science or Engineering with a strong concentration in mathematics.
  - Students who have a strong academic record but who have some gaps in their Applied Mathematics background may be admitted subject to the requirement that they complete a selection of fourth year undergraduate courses as part of their graduate program.

- Application materials
  - Résumé
• Supplementary information form
• Transcript(s)

• References
  • Number of references: 3
  • Type of references: normally from academic sources.

• English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

Thesis option:

• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  • Students must complete 4 one-term (0.50 unit) graduate courses, satisfying a breadth requirement. Candidates for the MMath (thesis) degree must maintain a grade point average of at least 70% in their coursework. Besides the breadth requirement, there are no other constraints on course selection.
  • Breadth requirement: students are required to take 1 Computation course and 1 Differential Equations or Techniques course, from the following list:
    ▪ Computation:
    • AMATH 740 Numerical Analysis
    • AMATH 741 Numerical Solution of Partial Differential Equations
    ▪ Differential Equations:
    • AMATH 751 Advanced Ordinary Differential Equations
    • AMATH 753 Advanced Partial Differential Equations
    • AMATH 777 Stochastic Processes in the Physical Sciences
    ▪ Techniques:
    • AMATH 731 Applied Functional Analysis
    • AMATH 732 Asymptotic Analysis and Perturbation Theory
  • Students may not count more than 1 graduate course that is cross-listed with an undergraduate course for credit towards their MMath (thesis) degree. This restriction applies to all 600-level AMATH courses and any cross-listed courses offered by other departments.
  • Courses are selected in consultation with the student's supervisor. Students are encouraged to select courses that will help them develop a broad knowledge of Mathematics and its applications: appropriate courses are often offered by other departments in the Faculties of Mathematics, Science and Engineering.

• Master’s Thesis
  • The MMath thesis is a comprehensive study that contributes to the understanding of a research topic, either by relating various approaches in the literature or by developing new methods. An MMath thesis is not required to contain original results. However, it is not uncommon for students - particularly those who have had research experience as undergraduates - to obtain new results that lead to publication in the research literature. For
University guidelines on co-authored material in Masters theses please visit the Graduate Studies Office website; additional departmental guidelines apply.

- The Master's thesis is read by a committee that consists of the thesis supervisor and two other faculty members who are knowledgeable about the research area. The supervisor and at least one of the other two committee members must be affiliated with the Department of Applied Mathematics.
- The student will present their results in a thesis defence, which consists of a 20 minute presentation by the candidate, followed by detailed questioning by the committee members. The thesis should be provided to the examining committee at least two weeks before the defence date.

- Other requirements
  - Direct transfer into the PhD program: A Master's student with an excellent record and strong progress in research may apply for direct transfer into the PhD program after one year of Master's studies. To initiate this process, the student's supervisor must submit a written request to the Graduate Officer. Names of two potential examiners should be included. The request should be accompanied by a statement of research progress to date, written by the student, approximately three pages in length. If the student's record is deemed to be of sufficient standing, the statement of research progress will be forwarded to the examining committee, and the student will be invited to present this summary at a 40 minute presentation followed by questioning by the examining committee. This examination normally takes place in the student's fourth term. If successful, the student is transferred directly into the PhD program and this examination then retroactively takes the place of the pre-comprehensive seminar, which is used by the student's committee to determine the topics for the comprehensive exam; that exam should take place in the student's fifth term.

Master's Research Paper option:

- Graduate Academic Integrity Module (Graduate AIM)

- Courses
  - Students must complete 7 one-term (0.50 unit) graduate courses, satisfying a breadth requirement. Candidates for the MMath (Research paper) degree must maintain a grade point average of at least 70% in their coursework. Besides the breadth requirement, there are no other constraints on course selection.
  - Breadth requirement: students are required to take 1 Computation course and 1 Differential Equations or Techniques course, from the following list:
    - Computation:
      - AMATH 740 Numerical Analysis
      - AMATH 741 Numerical Solution of Partial Differential Equations
    - Differential Equations:
      - AMATH 751 Advanced Ordinary Differential Equations
      - AMATH 753 Advanced Partial Differential Equations
      - AMATH 777 Stochastic Processes in the Physical Sciences
Techniques:
- AMATH 731 Applied Functional Analysis
- AMATH 732 Asymptotic Analysis and Perturbation Theory
  - Students may not count more than three graduate courses that are cross-listed with undergraduate courses for credit towards their MMath (thesis) degree. This restriction applies to all 600-level AMATH courses and any cross-listed courses offered by other departments.
  - Courses are selected in consultation with the student's supervisor. Students are encouraged to select courses that will help them develop a broad knowledge of Mathematics and its applications: appropriate courses are often offered by other departments in the Faculties of Mathematics, Science and Engineering.

- Master’s Research Paper
  - The Master's research paper is a review paper that is typically prepared over the course of one term. It should be 25-35 pages in length. The Master's research paper is assessed by the research supervisor and one other faculty member. There is no oral examination.

[Department of Applied Mathematics website]

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- The minimum requirements for admission to the Master of Mathematics (MMath) in Applied Mathematics program normally include:

- Proof of competency in English (if applicable). A score of at least 600 (250 on the computerized version and 100 on the Internet-based version) is required in the Test of English as a Foreign Language (TOEFL) and 4.0 on the TWE. See the English Language Proficiency page for other acceptable tests of English.
Accelerated Master's Program in Combinatorics and Optimization

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

The Accelerated Master's Program is available to qualified undergraduate students at the University of Waterloo who wish to begin graduate studies while still an undergraduate. This program offers the student several advantages:

- The time spent in the Master of Mathematics (MMath) in Combinatorics and Optimization program can be reduced by up to one term.
- The student can fill empty slots in his/her fourth year with more advanced courses or a cutting-edge research project.
- The student does not have to worry throughout fourth year about post-graduation plans since admission decisions to the accelerated MMath in Combinatorics and Optimization program are typically made before the 4th year begins.

The degree requirements are the same as for the regular MMath in Combinatorics and Optimization program. The program does not allow double-counting of courses for both undergraduate and graduate degree requirements, but it does allow students to take Bachelor of Mathematics (BMath) and MMath courses concurrently.

The co-op option is also available for this program.

Students must meet the following admission criteria:

- Major in Combinatorics and Optimization or related field.
- Average of at least 85% in all math courses.
- Have completed 3B term.

Students interested in the program should apply using the online web form and should include the following information in the Supplementary Information Form (part of the application):

- A clear statement that this application is for the accelerated MMath program.
- A detailed list of remaining requirements for BMath completion as well as a timetable for when these requirements are expected to be met.

Students should include at least three letters of recommendation as part of their application for MMath admission. No test scores are required.

Department of Combinatorics and Optimization website

Doctor of Philosophy (PhD) in Combinatorics and Optimization - Quantum Information

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.
Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Length of program
  - The normal period of registration for the PhD degree is 6 terms from a Master's degree. One year of credit may be granted by the Faculty Graduate Committee for work done towards the PhD degree at another institution, provided that the relevance of the previous work to the student's proposed program is clearly established.

- Program type
  - Doctoral
  - Collaborative
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - A Master's degree in combinatorics and optimization, or in a closely related field, with a minimum 89% average in Master's level coursework.
  - Completion of a master's thesis.
  - It is essential that the application for admission into the PhD program contains evidence of research ability or potential.
  - Students in the PhD program are regarded as being on probation during their first year in the Department, and their performance during this first year determines whether they are allowed to continue in the program. In particular, failure in any one course, or an unsatisfactory performance in the comprehensive examination, automatically results in a review of the student's progress by the Department Graduate Committee. PhD students' progress will be reviewed at least once per year.
  - A student who is enrolled in the Master of Mathematics (MMath) program in the Department of Combinatorics and Optimization and wishes to continue in the PhD program has to apply for admission into the program. In exceptional cases, a graduate student enrolled in a MMath (Thesis) program in the Department of Combinatorics and Optimization may, through the
Graduate Officer and with the consent of the Supervisor, petition the Graduate Committee to be transferred into a PhD program. The guidelines for such a transfer are as follows:

- The student has been enrolled in the MMath (Thesis) program for at least two terms.
- The student has made considerable progress in the research project (of the type that would warrant the MMath degree) and is committed to carrying the project to completion in a PhD program.
- The student gives a seminar presentation of the work carried out so far, and answers related questions to the satisfaction of an examining committee consisting of the supervisor and two other faculty members.

Students applying to the PhD program who hold a Master's degree from another university may, in some cases, be admitted initially into the MMath program. In such cases the Graduate Committee will decide, within three terms, whether to transfer the student into the PhD program.

- Application materials
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: normally from academic sources.

- English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

- Graduate Academic Integrity Module (Graduate AIM)

- Courses
  - Students must complete 8 courses, including the 2 Quantum Information core courses, and 3 other CO core courses. At least 5 of the courses taken should be CO courses and at least 4 should be QI courses (note that jointly offered or cross-listed courses, like CO681/QIC710, are regarded as both CO and QIC courses). The remaining course (if any) must be a graduate course in the Faculty of Mathematics, or a course approved by the CO Graduate Committee.
  - At least 6 courses should normally be completed within the first 6 terms.
  - Combinatorics and Optimization core courses:
    - CO 630 Algebraic Enumeration
    - CO 642 Graph Theory
    - CO 650 Combinatorial Optimization
    - CO 663 Convex Optimization and Analysis
    - CO 681 Quantum Information Processing
    - CO 685 The Mathematics of Public-Key Cryptography
  - Quantum Information core courses:
    - QIC 710 Quantum Information Processing (equivalent to CO 681 Quantum Information Processing)
    - QIC 750 Implementation of Quantum Information Processing
o If students have credit for a course deemed equivalent to a particular core course by the Department Graduate Committee, then that part of the core requirement may be waived.

o The Department may require additional coursework in cases where this is judged to be necessary; for instance, when a student is admitted to the PhD program without having been granted credit for a Master's degree.

- Graduate Studies Research Skills Seminar
  o Required for PhD students unless the student satisfied this requirement as a MMath student at the Department of Combinatorics and Optimization.

- PhD Quantum Information Seminar
  o Students must successfully complete a seminar milestone consisting of 1 Institute for Quantum Computing (IQC) seminar, and 1 seminar on a Quantum Information (QI) topic. If appropriate, lectures given as part of the Lecturing Requirement may also be used to satisfy the seminar requirement.

- PhD Lecturing Requirement
  o Every PhD student will be required to lecture under supervision during the program of studies. If a PhD student gives a scheduled course on a regular basis, the same two faculty members will attend three of the lectures and make a confidential, constructive critique of the student's performance to the student.
  o The PhD Lecturing Requirement should normally be completed within the first eight terms of the student’s PhD program. Students may not put their thesis on display until at least the term following that in which the Lecturing Requirement was successfully completed.

- PhD Comprehensive Examination
  o This requirement consists of 2 written examinations covering the fundamentals of combinatorics and optimization. These are usually offered once a year, in the spring term. The student must write one exam from two of the following three categories:
    - Combinatorial Enumeration, Graph Theory
    - Continuous Optimization, Discrete Optimization
    - Cryptography, Quantum Computing
  o The choice of exams is made by the student, in consultation with their supervisor. The exams must be taken within the first four terms of the student’s PhD program.
  o The PhD Comprehensive Examination requirement is satisfied by passing both examinations.

- PhD Thesis Proposal
  o The PhD Thesis Proposal is an oral exam at which the student is expected to give a brief description of the questions they propose to work on for the PhD and a summary of the main results in this area. This exam should normally be taken within the first six terms of the student’s PhD program. The student should provide a short written version of their thesis proposal to their committee one week before the oral presentation. The PhD Thesis Proposal requirement is satisfied by successful completion of this exam.
  o Advisory Committee: each student has an Advisory Committee, which normally consists of the student's supervisor and two other department members with expertise in the area of the student's research interests. The Advisory Committee acts as the examining committee at the
student's PhD Thesis Proposal, and is usually formed at this time. The members of the advisory committee will also usually act as examiners at the student's PhD defence. The Advisory Committee is selected by the Graduate Officer, who will consult the student and their supervisor.

- PhD Thesis
  - Students must prepare a thesis in Quantum Information, embodying the results of original research, of a standard that would warrant publication in a research journal of the field. The thesis must be acceptable to the student's supervisor, to two professors in the Department and one professor outside the Department, and to an external examiner familiar with the student's research field. The student is required to defend the thesis at an oral examination. This requirement is met when the thesis has been successfully defended and accepted.

Department of Combinatorics and Optimization website
Institute for Quantum Computing website

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- The University of Waterloo, home of the Institute for Quantum Computing (IQC), offers graduate students unique opportunities to learn about and engage in world-leading research in quantum information through a wide range of advanced research projects and advanced courses on the foundations, applications and implementation of quantum information processing.

In particular, the University of Waterloo offers a unique interdisciplinary graduate program in Quantum Information that leads to MMath, MSc, MASc, and PhD degrees. This program is a collaboration between the Institute for Quantum Computing and:

The Departments of Applied Mathematics, Combinatorics and Optimization, and the David R. Cheriton School of Computer Science in the Faculty of Mathematics
The Departments of Chemistry and Physics and Astronomy in the Faculty of Science
The Department of Electrical and Computer Engineering in the Faculty of Engineering

These academic units are referred to hereinafter as the home units.

MMath, MSc, and MASc students will receive both strong and broad foundations in quantum information science, coupled with knowledge and expertise obtained within their home programs. This will prepare them for the workforce and/or further graduate studies and research leading towards a PhD degree.

PhD students will be especially well-prepared for careers as scholars and researchers, with advanced expertise in quantum information science, together with the focus of their home programs. This new program is designed to provide students with knowledge of quantum information, including both theory and its implementations, advanced expertise in quantum information science and in home program disciplines, as well as training in research.
Admission requirements are the same as those of the home programs. The home unit in which an applicant intends to pursue graduate study must approve the application. Interested students should apply directly to one of the following units via the regular university application process:

Department of Applied Mathematics
Department of Chemistry
Department of Combinatorics and Optimization
David R. Cheriton School of Computer Science
Department of Electrical and Computer Engineering
Department of Physics and Astronomy

Information specific to the Department of Combinatorics and Optimization is given below.

- Admission requirements are the same as those for PhD in Combinatorics and Optimization. Please refer to the Department of Combinatorics and Optimization website.

- For the PhD in Combinatorics & Optimization (Quantum Information), students must fulfill the requirements of the Combinatorics & Optimization PhD in addition to the specific requirements for the Quantum Information program: these combined requirements are described here.

- A handout giving more details is available from the Graduate Secretary.

- A current listing of Quantum Information thesis supervisors and their home unit is available on the IQC website.

- An updated list of Quantum Information courses is available on the IQC website.

- For more information, please contact:
  Melissa Cambridge
  Combinatorics & Optimization, Graduate Studies
  Email: m2cambridge@uwaterloo.ca
  Phone: 519-888-4567 ext. 34027
  or
  Monica Dey
  Institute for Quantum Computing
  University of Waterloo
  E-mail: mdey@iqc.ca
  Phone: 519-888-4567 ext. 38702
Doctor of Philosophy (PhD) in Combinatorics and Optimization

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Algebraic Combinatorics
- Continuous Optimization
- Cryptography
- Discrete Optimization
- Graph Theory
- Quantum Computing

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Length of program
  - The normal period of registration for the PhD degree is 6 terms from a Master's degree. One year of credit may be granted by the Faculty Graduate Committee for work done towards the PhD degree at another institution, provided that the relevance of the previous work to the student's proposed program is clearly established.

- Program type
  - Doctoral
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - A Master's degree in combinatorics and optimization, or in a closely related field, with a minimum 89% average in Master's level coursework.
  - Completion of a master's thesis.
It is essential that the application for admission into the PhD program contains evidence of research ability or potential.

Students in the PhD program are regarded as being on probation during their first year in the Department, and their performance during this first year determines whether they are allowed to continue in the program. In particular, failure in any one course, or an unsatisfactory performance in the comprehensive examination, automatically results in a review of the student's progress by the Department Graduate Committee. PhD students' progress will be reviewed at least once per year.

A student who is enrolled in the Master of Mathematics (MMath) program in the Department of Combinatorics and Optimization and wishes to continue in the PhD program has to apply for admission into the program. In exceptional cases, a graduate student enrolled in a MMath (Thesis) program in the Department of Combinatorics and Optimization may, through the Graduate Officer and with the consent of the Supervisor, petition the Graduate Committee to be transferred into a PhD program. The guidelines for such a transfer are as follows:

- The student has been enrolled in the MMath (Thesis) program for at least two terms.
- The student has made considerable progress in the research project (of the type that would warrant the MMath degree) and is committed to carrying the project to completion in a PhD program.
- The student gives a seminar presentation of the work carried out so far, and answers related questions to the satisfaction of an examining committee consisting of the supervisor and two other faculty members.

Students applying to the PhD program who hold a Master's degree from another university may, in some cases, be admitted initially into the MMath program. In such cases the Graduate Committee will decide, within three terms, whether to transfer the student into the PhD program.

Application materials
- Supplementary information form
- Transcript(s)

References
- Number of references: 3
- Type of references: normally from academic sources.

English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements
- Graduate Academic Integrity Module (Graduate AIM)
- Courses
  - Students must complete 8 courses, including 4 core courses and at least 1 other CO course. The remaining 3 courses must be graduate courses in the Faculty of Mathematics, or courses approved by the CO Graduate Committee.
  - At least 6 courses should normally be completed within the first 6 terms.
  - Core courses:
- CO 630 Algebraic Enumeration
- CO 642 Graph Theory
- CO 650 Combinatorial Optimization
- CO 663 Convex Optimization and Analysis
- CO 681 Quantum Information Processing
- CO 685 The Mathematics of Public-Key Cryptography

- If students have credit for a course deemed equivalent to a particular core course by the Department Graduate Committee, then that part of the core requirement may be waived.
- The Department may require additional coursework in cases where this is judged to be necessary; for instance, when a student is admitted to the PhD program without having been granted credit for a Master's degree.

- Graduate Studies Research Skills Seminar
  - Required for PhD students unless the student satisfied this requirement as a MMath student at the Department of Combinatorics and Optimization.

- PhD Lecturing Requirement
  - Every PhD student will be required to lecture under supervision during the program of studies. If a PhD student gives a scheduled course on a regular basis, the same two faculty members will attend three of the lectures and make a confidential, constructive critique of the student's performance to the student.
  - The PhD Lecturing Requirement should normally be completed within the first eight terms of the student’s PhD program. Students may not put their thesis on display until at least the term following that in which the Lecturing Requirement was successfully completed.

- PhD Comprehensive Examination
  - This requirement consists of 2 written examinations covering the fundamentals of combinatorics and optimization. These are usually offered once a year, in the spring term. The student must write one exam from two of the following three categories:
    - Combinatorial Enumeration, Graph Theory
    - Continuous Optimization, Discrete Optimization
    - Cryptography, Quantum Computing
  - The choice of exams is made by the student, in consultation with their supervisor. The exams must be taken within the first four terms of the student’s PhD program.
  - The PhD Comprehensive Examination requirement is satisfied by passing both examinations.

- PhD Thesis Proposal
  - The PhD Thesis Proposal is an oral exam at which the student is expected to give a brief description of the questions they propose to work on for the PhD and a summary of the main results in this area. This exam should normally be taken within the first six terms of the student’s PhD program. The student should provide a short written version of their thesis proposal to their committee one week before the oral presentation. The PhD Thesis Proposal requirement is satisfied by successful completion of this exam.
  - Advisory Committee: each student has an Advisory Committee, which normally consists of the student's supervisor and two other department members with expertise in the area of the
student's research interests. The Advisory Committee acts as the examining committee at the student's PhD Thesis Proposal, and is usually formed at this time. The members of the advisory committee will also usually act as examiners at the student's PhD defence. The Advisory Committee is selected by the Graduate Officer, who will consult the student and their supervisor.

- **PhD Thesis**
  - Students must prepare a thesis, embodying the results of original research, of a standard that would warrant publication in a research journal of the field. The thesis must be acceptable to the student's supervisor, to two professors in the Department and one professor outside the Department, and to an external examiner familiar with the student's research field. The student is required to defend the thesis at an oral examination. This requirement is met when the thesis has been successfully defended and accepted.

[Department of Combinatorics and Optimization website](#)

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- The minimum requirements for admission to the PhD program normally include:

- Proof of competency in English (if applicable). A score of at least 580 is required in the Test of English as a Foreign Language (TOEFL). (See Academic Regulations - English Language Proficiency Certification for other acceptable tests of English.)

- A handout giving more details is available from the Graduate Secretary.

**Master of Mathematics (MMath) in Combinatorics and Optimization - Co-operative Program**

Students are responsible for reviewing the [General Information and Regulations section of the Graduate Studies Academic Calendar](#).

**Fields (areas of research)**

- Algebraic Combinatorics
- Continuous Optimization
- Cryptography
- Discrete Optimization
- Graph Theory
- Quantum Computing

**Program information**

- Admit term(s)
  - Fall
  - Winter
• Delivery mode(s)
  o On-campus

• Length of program
  o At least two terms of full-time registration. Students should normally complete the MMath degree in one year (three semesters).

• Program type
  o Master’s
  o Co-operative
  o Research

• Registration option(s)
  o Full-time
  o Part-time

• Study option(s)
  o Thesis
  o Master’s Research Paper

Admission requirements

• Minimum requirements
  o A four-year Honours Bachelor degree or its equivalent in mathematics or in a closely related field with a 78% overall average or its equivalent for undergraduate work.
  o Applicants from foreign countries must normally take the Graduate Record Examinations (GRE) General Test and Subject Tests.

• Application materials
  o Supplementary information form
  o Transcript(s)

• References
  o Number of references: 3
  o Type of references: normally from academic sources.

• English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

Combinatorics and Optimization (C&O) Core

Thesis option:

• Graduate Academic Integrity Module (Graduate AIM)
Courses
- Students must complete 4 courses, including 2 core courses and at least 1 other CO course. The 4th required course must be a graduate course in the Faculty of Mathematics, or a course approved by the CO Graduate Committee.
  - Core courses:
    - CO 630 Algebraic Enumeration
    - CO 642 Graph Theory
    - CO 650 Combinatorial Optimization
    - CO 663 Convex Optimization and Analysis
    - CO 681 Quantum Information Processing
    - CO 685 The Mathematics of Public-Key Cryptography
  - If students have credit for a course deemed equivalent to a particular required course by the Department Graduate Committee, then that part of the core requirement may be waived. An overall average of at least 75% must be maintained.
  - A student may obtain credit for one graduate term course by completing two undergraduate term courses; however, any student wishing to exercise this option must seek the approval of the Department Graduate Committee.
  - Unsatisfactory academic performance in any one course will result in a review of the student's status by the Department Graduate Committee. If a student with a failed course is permitted to continue, additional work may be required to clear the failure in that course, or by replacement of the failed course; alternatively, the student may be required to repeat part or all of the program.
  - Students without the required prerequisite knowledge may find it necessary to complete some courses at the 3rd or 4th year undergraduate level before proceeding to the core courses. The core courses may be replaced with other courses provided the Department Graduate Committee agrees that they are equivalent. The choice of the precise set of core courses is left to the student and the student's supervisor.

Graduate Studies Research Skills Seminar

Graduate Studies Work Report
- Students must complete a 2-term co-op work placement with a suitable industrial organization. The work placement must be related to the student's research and is subject to the approval of the Graduate Committee and the student's research supervisor. After completing the work placement, the student is required to submit a work report and make a formal oral presentation.

Master’s Thesis
- The thesis requirement consists of the writing of an expository or research thesis. The thesis topic is to be arranged with a faculty member who serves as the Thesis Supervisor. This requirement is met, and credit assigned, when the Thesis Supervisor and two additional readers approve the thesis. In addition to distributing a copy of the MMath thesis to the supervisor and readers, the thesis should also be deposited in the Mathematics Graduate Office for display for a period of three weeks.

Master’s Research Paper option:
Courses

Students must complete 7 courses, including 3 core courses and at least 1 other CO course. The remaining 3 courses must be graduate courses in the Faculty of Mathematics, or courses approved by the CO Graduate Committee.

Core courses:
- CO 630 Algebraic Enumeration
- CO 642 Graph Theory
- CO 650 Combinatorial Optimization
- CO 663 Convex Optimization and Analysis
- CO 681 Quantum Information Processing
- CO 685 The Mathematics of Public-Key Cryptography

If students have credit for a course deemed equivalent to a particular required course by the Department Graduate Committee, then that part of the core requirement may be waived. An overall average of at least 75% must be maintained.

A student may obtain credit for one graduate term course by completing two undergraduate term courses; however, any student wishing to exercise this option must seek the approval of the Department Graduate Committee.

Unsatisfactory academic performance in any one course will result in a review of the student's status by the Department Graduate Committee. If a student with a failed course is permitted to continue, additional work may be required to clear the failure in that course, or by replacement of the failed course; alternatively, the student may be required to repeat part or all of the program.

Students without the required prerequisite knowledge may find it necessary to complete some courses at the 3rd or 4th year undergraduate level before proceeding to the core courses. The core courses may be replaced with other courses provided the Department Graduate Committee agrees that they are equivalent. The choice of the precise set of core courses is left to the student and the student's supervisor.

Graduate Studies Research Skills Seminar

Graduate Studies Work Report

Students must complete a 2-term co-op work placement with a suitable industrial organization. The work placement must be related to the student's research and is subject to the approval of the Graduate Committee and the student's research supervisor. After completing the work placement, the student is required to submit a work report and make a formal oral presentation.

Master's Research Paper

This requirement consists of two parts: the writing of a research paper, and the presentation of it in an appropriate seminar or class. The topic is arranged with the student's supervisor. The research paper requirement is met, and credit assigned, when the supervisor and reader return a signed Accreditation form to the Department Graduate Officer, approving the written document and the research paper presentation.
Mathematics of Operations Research (MOR) Core

Thesis option:

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete 4 courses, including CO 650 Combinatorial Optimization, CO 666 Continuous Optimization, and 2 core courses.
  - Core courses:
    - CO 652 Integer Programming
    - CO 663 Convex Optimization and Analysis
    - CO 671 Semidefinite Optimization
    - MSCI 631 Probabilistic Models in Operations Research
    - MSCI 632 Discrete Event Simulation
    - STAT 833 Stochastic Processes
    - STAT 835 Statistical Methods for Process Improvement
  - If students have credit for a course deemed equivalent to a particular required course by the Department Graduate Committee, then that part of the core requirement may be waived. An overall average of at least 75% must be maintained.
  - A student may obtain credit for one graduate term course by completing two undergraduate term courses; however, any student wishing to exercise this option must seek the approval of the Department Graduate Committee.
  - Unsatisfactory academic performance in any one course will result in a review of the student's status by the Department Graduate Committee. If a student with a failed course is permitted to continue, additional work may be required to clear the failure in that course, or by replacement of the failed course; alternatively, the student may be required to repeat part or all of the program.
  - Students without the required prerequisite knowledge may find it necessary to complete some courses at the 3rd or 4th year undergraduate level before proceeding to the core courses. The core courses may be replaced with other courses provided the Department Graduate Committee agrees that they are equivalent. The choice of the precise set of core courses is left to the student and the student's supervisor.

- **Graduate Studies Research Skills Seminar**

- **Graduate Studies Work Report**
  - Students must complete a 2-term co-op work placement with a suitable industrial organization. The work placement must be related to the student's research and is subject to the approval of the Graduate Committee and the student's research supervisor. After completing the work placement, the student is required to submit a work report and make a formal oral presentation.

- **Thesis**
  - The thesis requirement consists of the writing of an expository or research thesis. The thesis topic is to be arranged with a faculty member who serves as the Thesis Supervisor. This requirement is met, and credit assigned, when the Thesis Supervisor and two additional
readers approve the thesis. In addition to distributing a copy of the MMath thesis to the supervisor and readers, the thesis should also be deposited in the Mathematics Graduate Office for display for a period of three weeks.

Master’s Research Paper option:

- Graduate Academic Integrity Module (Graduate AIM)

- Courses
  - Students must complete 7 courses, including CO 650 Combinatorial Optimization, CO 666 Continuous Optimization, 2 core courses and at least 3 other courses.
  - Core courses:
    - CO 652 Integer Programming
    - CO 663 Convex Optimization and Analysis
    - CO 671 Semidefinite Optimization
    - MSCI 631 Probabilistic Models in Operations Research
    - MSCI 632 Discrete Event Simulation
    - STAT 833 Stochastic Processes
    - STAT 835 Statistical Methods for Process Improvement
  - The remaining 3 courses must be graduate courses in the Faculty of Mathematics, or courses approved by the CO Graduate Committee. It is recommended that they be selected from CO 652, CO 663, CO 664, CO 671, CS 657, and STAT 833.
  - If students have credit for a course deemed equivalent to a particular required course by the Department Graduate Committee, then that part of the core requirement may be waived. An overall average of at least 75% must be maintained.
  - A student may obtain credit for one graduate term course by completing two undergraduate term courses; however, any student wishing to exercise this option must seek the approval of the Department Graduate Committee.
  - Unsatisfactory academic performance in any one course will result in a review of the student's status by the Department Graduate Committee. If a student with a failed course is permitted to continue, additional work may be required to clear the failure in that course, or by replacement of the failed course; alternatively, the student may be required to repeat part or all of the program.
  - Students without the required prerequisite knowledge may find it necessary to complete some courses at the 3rd or 4th year undergraduate level before proceeding to the core courses. The core courses may be replaced with other courses provided the Department Graduate Committee agrees that they are equivalent. The choice of the precise set of core courses is left to the student and the student's supervisor.

- Graduate Studies Research Skills Seminar

- Graduate Studies Work Report
  - Students must complete a 2-term co-op work placement with a suitable industrial organization. The work placement must be related to the student's research and is subject to the approval of the Graduate Committee and the student's research supervisor. After
completing the work placement, the student is required to submit a work report and make a formal oral presentation.

- **Master’s Research Paper**
  - This requirement consists of two parts: the writing of a research paper, and the presentation of it in an appropriate seminar or class. The topic is arranged with the student's supervisor. The research paper requirement is met, and credit assigned, when the supervisor and reader return a signed Accreditation form to the Department Graduate Officer, approving the written document and the research paper presentation.

**Department of Combinatorics and Optimization website**

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- The minimum requirements for admission to the Master of Mathematics (MMath) program normally include:

- Proof of proficiency in English (if applicable); accepted examinations and required minimum scores for graduate studies are listed on the English Language Proficiency page;

- All MMath students must satisfactorily complete one of two core programs, outlined below.
Master of Mathematics (MMath) in Combinatorics and Optimization - Quantum Information

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Length of program
  - At least two terms of full-time registration. Students should normally complete the MMath degree in one year (three semesters).

- Program type
  - Master’s
  - Collaborative
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis

Admission requirements

- Minimum requirements
  - A four-year Honours Bachelor degree or its equivalent in mathematics or in a closely related field with a 78% overall average or its equivalent for undergraduate work.
  - Applicants from foreign countries must normally take the Graduate Record Examinations (GRE) General Test and Subject Tests.

- Application materials
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
  - Type of references: normally from academic sources.
Degree requirements

- **English Language Proficiency Certification (ELPC)** (if applicable)

Courses

- Students must complete 4 courses, including the 2 Quantum Information core courses, 1 other CO core course, and at least 1 other CO course.
- Combinatorics and Optimization core courses:
  - CO 630 Algebraic Enumeration
  - CO 642 Graph Theory
  - CO 650 Combinatorial Optimization
  - CO 663 Convex Optimization and Analysis
  - CO 681 Quantum Information Processing
  - CO 685 The Mathematics of Public-Key Cryptography
- Quantum Information core courses:
  - QIC 710 Quantum Information Processing (equivalent to CO 681 Quantum Information Processing)
  - QIC 750 Implementation of Quantum Information Processing
- If students have credit for a course deemed equivalent to a particular required course by the Department Graduate Committee, then that part of the core requirement may be waived. An overall average of at least 75% must be maintained.
- A student may obtain credit for one graduate term course by completing two undergraduate term courses; however, any student wishing to exercise this option must seek the approval of the Department Graduate Committee.
- Unsatisfactory academic performance in any one course will result in a review of the student's status by the Department Graduate Committee. If a student with a failed course is permitted to continue, additional work may be required to clear the failure in that course, or by replacement of the failed course; alternatively, the student may be required to repeat part or all of the program.
- Students without the required prerequisite knowledge may find it necessary to complete some courses at the 3rd or 4th year undergraduate level before proceeding to the core courses. The core courses may be replaced with other courses provided the Department Graduate Committee agrees that they are equivalent. The choice of the precise set of core courses is left to the student and the student's supervisor.

- **Graduate Studies Research Skills Seminar**

- **Master’s Thesis**
  - The thesis requirement consists of the writing of an expository or research thesis in Quantum Information. The thesis topic is to be arranged with a faculty member who serves as the Thesis Supervisor. This requirement is met, and credit assigned, when the Thesis Supervisor and two additional readers approve the thesis. In addition to distributing a copy of the MMath thesis...
to the supervisor and readers, the thesis should also be deposited in the Mathematics Graduate Office for display for a period of three weeks.

Department of Combinatorics and Optimization website
Institute for Quantum Computing website

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- The University of Waterloo, home of the Institute for Quantum Computing (IQC), offers graduate students unique opportunities to learn about and engage in world-leading research in quantum information through a wide range of advanced research projects and advanced courses on the foundations, applications and implementation of quantum information processing.

In particular, the University of Waterloo offers a unique interdisciplinary graduate program in Quantum Information that leads to MMath, MSc, MASc, and PhD degrees. This program is collaboration between the Institute for Quantum Computing and:

The Departments of Applied Mathematics, Combinatorics and Optimization, and the David R. Cheriton School of Computer Science in the Faculty of Mathematics
The Departments of Chemistry and Physics and Astronomy in the Faculty of Science
The Department of Electrical and Computer Engineering in the Faculty of Engineering

These academic units are referred to hereinafter as the home units.

MMath, MSc, and MASc students will receive both strong and broad foundations in quantum information science, coupled with knowledge and expertise obtained within their home programs. This will prepare them for the workforce and/or further graduate studies and research leading towards a PhD degree.

PhD students will be especially well-prepared for careers as scholars and researchers, with advanced expertise in quantum information science, together with the focus of their home programs. This new program is designed to provide students with knowledge of quantum information, including both theory and its implementations, advanced expertise in quantum information science and in home program disciplines, as well as training in research.

Admission requirements are the same as those of the home programs. The home unit in which an applicant intends to pursue graduate study must approve the application. Interested students should apply directly to one of the following units via the regular university application process:

Department of Applied Mathematics
Department of Chemistry
Department of Combinatorics and Optimization
David R. Cheriton School of Computer Science
Department of Electrical and Computer Engineering
Department of Physics and Astronomy

Information specific to the Department of Combinatorics and Optimization is given below.
• Admission requirements are the same as those for MMath in Combinatorics and Optimization. Please refer to the Department of Combinatorics and Optimization website.

• All MMath students must satisfactorily complete one of two core programs, outlined below.

• Co-op option: Degree requirements are the same as for the regular MMath program, with the addition of a 2-term co-op work placement with a suitable industrial organization. The work placement must be related to the student's research and is subject to the approval of the Graduate Committee and the student's research supervisor. After completing the work placement, the student is required to submit a work report and make a formal oral presentation.

• A current listing of Quantum Information thesis supervisors and their home unit is available on the IQC website

• An updated list of Quantum Information courses is available on the IQC website.

For more information, please contact:

Melissa Cambridge  
Combinatorics & Optimization, Graduate Studies  
Email: m2cambridge@uwaterloo.ca  
Phone: 519-888-4567 ext. 34027  
or  
Monica Dey  
Institute for Quantum Computing  
University of Waterloo  
E-mail: mdey@iqc.ca  
Phone: 519-888-4567 ext. 38702
Master of Mathematics (MMath) in Combinatorics and Optimization

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Fields (areas of research)

- Algebraic Combinatorics
- Continuous Optimization
- Cryptography
- Discrete Optimization
- Graph Theory
- Quantum Computing

Program information

- Admit term(s)
  - Fall
  - Winter
  - Spring

- Delivery mode(s)
  - On-campus

- Length of program
  - At least two terms of full-time registration. Students should normally complete the MMath degree in one year (three semesters).

- Program type
  - Master’s
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Thesis
  - Master’s Research Paper

Admission requirements

- Minimum requirements
  - A four-year Honours Bachelor degree or its equivalent in mathematics or in a closely related field with a 78% overall average or its equivalent for undergraduate work.
  - Applicants from foreign countries must normally take the Graduate Record Examinations (GRE) General Test and Subject Tests.
• Application materials
  o Supplementary information form
  o Transcript(s)

• References
  o Number of references: 3
  o Type of references: normally from academic sources.

• English Language Proficiency Certification (ELPC) (if applicable)

Degree requirements

Combinatorics and Optimization (C&O) Core

Thesis option:

• Graduate Academic Integrity Module (Graduate AIM)

• Courses
  o Students must complete 4 courses, including 2 core courses and at least 1 other C&O course. The 4th required course must be a graduate course in the Faculty of Mathematics, or a course approved by the CO Graduate Committee.
  o Core courses:
    ▪ CO 630 Algebraic Enumeration
    ▪ CO 642 Graph Theory
    ▪ CO 650 Combinatorial Optimization
    ▪ CO 663 Convex Optimization and Analysis
    ▪ CO 681 Quantum Information Processing
    ▪ CO 685 The Mathematics of Public-Key Cryptography
  o If students have credit for a course deemed equivalent to a particular required course by the Department Graduate Committee, then that part of the core requirement may be waived. An overall average of at least 75% must be maintained.
  o A student may obtain credit for one graduate term course by completing two undergraduate term courses; however, any student wishing to exercise this option must seek the approval of the Department Graduate Committee.
  o Unsatisfactory academic performance in any one course will result in a review of the student’s status by the Department Graduate Committee. If a student with a failed course is permitted to continue, additional work may be required to clear the failure in that course, or by replacement of the failed course; alternatively, the student may be required to repeat part or all of the program.
  o Students without the required prerequisite knowledge may find it necessary to complete some courses at the 3rd or 4th year undergraduate level before proceeding to the core courses. The core courses may be replaced with other courses provided the Department Graduate Committee agrees that they are equivalent. The choice of the precise set of core courses is left to the student and the student’s supervisor.
Master's Thesis

- The thesis requirement consists of the writing of an expository or research thesis. The thesis topic is to be arranged with a faculty member who serves as the Thesis Supervisor. This requirement is met, and credit assigned, when the Thesis Supervisor and two additional readers approve the thesis. In addition to distributing a copy of the MMath thesis to the supervisor and readers, the thesis should also be deposited in the Mathematics Graduate Office for display for a period of three weeks.

Master's Research Paper option:

- Graduate Academic Integrity Module (Graduate AIM)

Courses

- Students must complete 7 courses, including 3 core courses and at least 1 other CO course. The remaining 3 courses must be graduate courses in the Faculty of Mathematics, or courses approved by the CO Graduate Committee.
  - Core courses:
    - CO 630 Algebraic Enumeration
    - CO 642 Graph Theory
    - CO 650 Combinatorial Optimization
    - CO 663 Convex Optimization and Analysis
    - CO 681 Quantum Information Processing
    - CO 685 The Mathematics of Public-Key Cryptography
  - If students have credit for a course deemed equivalent to a particular required course by the Department Graduate Committee, then that part of the core requirement may be waived. An overall average of at least 75% must be maintained.
  - A student may obtain credit for one graduate term course by completing two undergraduate term courses; however, any student wishing to exercise this option must seek the approval of the Department Graduate Committee.
  - Unsatisfactory academic performance in any one course will result in a review of the student's status by the Department Graduate Committee. If a student with a failed course is permitted to continue, additional work may be required to clear the failure in that course, or by replacement of the failed course; alternatively, the student may be required to repeat part or all of the program.
  - Students without the required prerequisite knowledge may find it necessary to complete some courses at the 3rd or 4th year undergraduate level before proceeding to the core courses. The core courses may be replaced with other courses provided the Department Graduate Committee agrees that they are equivalent. The choice of the precise set of core courses is left to the student and the student's supervisor.
This requirement consists of two parts: the writing of a research paper, and the presentation of it in an appropriate seminar or class. The topic is arranged with the student's supervisor. The research paper requirement is met, and credit assigned, when the supervisor and reader return a signed Accreditation form to the Department Graduate Officer, approving the written document and the research paper presentation.

**Mathematics of Operations Research (MOR) Core**

**Thesis option:**

- **Graduate Academic Integrity Module (Graduate AIM)**
- **Courses**
  - Students must complete 4 courses, including CO 650 Combinatorial Optimization, CO 666 Continuous Optimization, and 2 core courses.
  - Core courses:
    - CO 652 Integer Programming
    - CO 663 Convex Optimization and Analysis
    - CO 671 Semidefinite Optimization
    - MSCI 631 Probabilistic Models in Operations Research
    - MSCI 632 Discrete Event Simulation
    - STAT 833 Stochastic Processes
    - STAT 835 Statistical Methods for Process Improvement
  - If students have credit for a course deemed equivalent to a particular required course by the Department Graduate Committee, then that part of the core requirement may be waived. An overall average of at least 75% must be maintained.
  - A student may obtain credit for one graduate term course by completing two undergraduate term courses; however, any student wishing to exercise this option must seek the approval of the Department Graduate Committee.
  - Unsatisfactory academic performance in any one course will result in a review of the student's status by the Department Graduate Committee. If a student with a failed course is permitted to continue, additional work may be required to clear the failure in that course, or by replacement of the failed course; alternatively, the student may be required to repeat part or all of the program.
  - Students without the required prerequisite knowledge may find it necessary to complete some courses at the 3rd or 4th year undergraduate level before proceeding to the core courses. The core courses may be replaced with other courses provided the Department Graduate Committee agrees that they are equivalent. The choice of the precise set of core courses is left to the student and the student's supervisor.
- **Graduate Studies Research Skills Seminar**
- **Master's Thesis**
  - The thesis requirement consists of the writing of an expository or research thesis. The thesis topic is to be arranged with a faculty member who serves as the Thesis Supervisor. This requirement is met, and credit assigned, when the Thesis Supervisor and two additional readers approve the thesis. In addition to distributing a copy of the MMath thesis to the
supervisor and readers, the thesis should also be deposited in the Mathematics Graduate Office for display for a period of three weeks.

**Master’s Research Paper option:**

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students must complete 7 courses, including CO 650 Combinatorial Optimization, CO 666 Continuous Optimization, 2 core courses and at least 3 other courses.
  - **Core courses:**
    - CO 652 Integer Programming
    - CO 663 Convex Optimization and Analysis
    - CO 671 Semidefinite Optimization
    - MSCI 631 Probabilistic Models in Operations Research
    - MSCI 632 Discrete Event Simulation
    - STAT 833 Stochastic Processes
    - STAT 835 Statistical Methods for Process Improvement
  - The remaining 3 courses must be graduate courses in the Faculty of Mathematics, or courses approved by the CO Graduate Committee. It is recommended that they be selected from CO 652, CO 663, CO 664, CO 671, CS 657, and STAT 833.
  - If students have credit for a course deemed equivalent to a particular required course by the Department Graduate Committee, then that part of the core requirement may be waived. An overall average of at least 75% must be maintained.
  - A student may obtain credit for one graduate term course by completing two undergraduate term courses; however, any student wishing to exercise this option must seek the approval of the Department Graduate Committee.
  - Unsatisfactory academic performance in any one course will result in a review of the student's status by the Department Graduate Committee. If a student with a failed course is permitted to continue, additional work may be required to clear the failure in that course, or by replacement of the failed course; alternatively, the student may be required to repeat part or all of the program.
  - Students without the required prerequisite knowledge may find it necessary to complete some courses at the 3rd or 4th year undergraduate level before proceeding to the core courses. The core courses may be replaced with other courses provided the Department Graduate Committee agrees that they are equivalent. The choice of the precise set of core courses is left to the student and the student’s supervisor.

- **Graduate Studies Research Skills Seminar**

- **Master’s Research Paper**
  - This requirement consists of two parts: the writing of a research paper, and the presentation of it in an appropriate seminar or class. The topic is arranged with the student's supervisor. The research paper requirement is met, and credit assigned, when the supervisor and reader return a signed Accreditation form to the Department Graduate Officer, approving the written document and the research paper presentation.
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- The minimum requirements for admission to the Master of Mathematics (MMath) program normally include:

- Proof of proficiency in English (if applicable); accepted examinations and required minimum scores for graduate studies are listed on the English Language Proficiency page;

- All MMath students must satisfactorily complete one of two core programs, outlined below.
Master of Mathematics (MMath) in Computational Mathematics

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- Admit term(s)
  - Fall

- Delivery mode(s)
  - On-campus

- Length of program
  - Full-time: one year.
  - Part-time: students will be expected to complete the program in a time period of two to three years. The minimum duration of study for part-time students is two years.

- Program type
  - Master’s
  - Research

- Registration option(s)
  - Full-time
  - Part-time

- Study option(s)
  - Master’s Research Paper

Admission requirements

- Minimum requirements
  - An overall 78% average or its equivalent for undergraduate work.
  - A 4-year honours bachelor's degree or its equivalent with specialization in some area of the mathematical, statistical and computer sciences. Note: graduates of other quantitative and mathematically oriented programs are also encouraged to apply; this includes, but is not restricted to, graduates of commerce, economics, engineering, finance, and any of the physical sciences. The department graduate committee will determine the suitability of each student’s background for success in this program.

- Application materials
  - Résumé
  - Supplementary information form
  - Transcript(s)

- References
  - Number of references: 3
- Type of references: normally from academic sources.

- **English Language Proficiency Certification (ELPC)** (if applicable)

**Degree requirements**

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  
  - Students are required to take 6 (0.50 unit weight) courses from lists A and B below. At least 4 courses must be taken from list A.
  
  - **List A Core Courses:**
    - CM 730/CS 687 Introduction to Symbolic Computation
    - 1 of CM 740/CO 602 Fundamentals of Optimization; CM 741/CO 666 Continuous Optimization
    - CM 750/AMATH 741/CS 778 Numerical Solution of Partial Differential Equations
    - 1 of CM 761/STAT 840 Computational Inference; CM 762/STAT 842 Data Visualization; CM 763/STAT 841 Statistical Learning - Classification; CM 764/STAT 844 Statistical Learning - Function Estimation
    - CM 770 (AMATH 740/CS 770) Numerical Analysis
  
  - **List B Courses** (typically held with undergraduate courses):
    - CO 650 Combinatorial Optimization
    - CO 652 Integer Programming
    - CO 663 Convex Optimization and Analysis
    - CO 666 Continuous Optimization
    - CO 671 Semi-definite Optimization
    - CO 681 (CS 667) Quantum Information Processing
    - CO 685 The Mathematics of Public-Key Cryptography
    - CO 687 Applied Cryptography
    - CO 778 (ACTSC 973) Portfolio Optimization
    - CO 781 Topics in Quantum Information
    - CS 666 Algorithm Design and Analysis
    - CS 673 Medical Image Processing
    - CS 676 Numeric Computation for Financial Modelling
    - CS 682 Computational Techniques in Biological Sequence Analysis
    - CS 683 Computational Techniques in Structural Bioinformatics
    - CS 686 Introduction to Artificial Intelligence
    - CS 688 Introduction to Computer Graphics
    - CS 763 Computational Geometry
    - CS 774 Advanced Computational Finance
    - CS 775 Parallel Algorithms in Scientific Computing
    - CS 780 Advanced Symbolic Computation
    - CS 786 Probabilistic Inference and Machine Learning
    - CS 787 Computational Vision
    - CS 867 Advanced Topics in Quantum Information and Computation
    - STAT 846 Mathematical Models in Finance
• STAT 901 Theory of Probability
• ACTSC 970 Finance 1
• AMATH 655 Control Theory
• AMATH 663 Fluid Mechanics
• AMATH 731 Applied Functional Analysis
• AMATH 753 Advanced PDEs
• AMATH 881 Introduction to Mathematical Oncology
• AMATH 882 Mathematical Cell Biology
• Any other course at this level approved by the graduate committee.

o The courses listed above are regularly offered within the Faculty. Other advanced courses are offered within the Faculty of Mathematics on topics of computational mathematics on a more irregular basis. These courses may be taken with approval of the Graduate Committee. Similarly, courses offered outside the Faculty, in Computational Mathematics or in some area of its application may be approved by the Graduate Committee. At most 2 of the 6 courses taken may be courses in which undergraduate students predominate.

o Students with strong backgrounds in some core areas may be granted exemption from the corresponding core courses required by the program; in each such case another course will be substituted for the exempted course so that the total courses required remains the same.

o Students must maintain an average of 70% in order to remain in good standing. Formal progress reports will be required in the event that a student wishes or needs to remain in the program longer than one year.

• Master’s Research Paper
  o Students must undertake an independent research project culminating in a research paper (1.00 unit weight). It is intended that the research project will be approximately the equivalent of two full courses and will be conducted under the direction of the student’s research supervisor. To be successfully completed, the research paper must be unanimously approved by the student’s advisory committee, consisting of the student’s research supervisor and one additional reader.
  o Students are also required to attend a Symposium, which normally takes place the third week in August, to present their research papers.

[Computational Mathematics website]
The Master of Mathematics (MMath) program in Computational Mathematics (CM) is administered through the Centre of Computational Mathematics in Industry and Commerce (CCMIC). It is expected that students will normally take twelve months to complete the program.

Or its equivalent for undergraduate work.

Applications will be made to the CCMIC, according to the usual procedures for the Faculty of Mathematics. The Graduate Program Committee of the CCMIC will review applications and make appropriate recommendations. The CM graduate committee will determine the suitability of each applicant's background for success in this program.

The program is targeted to students with a bachelor's degree in mathematics, statistics, or computer science, or in another program with a strong mathematical component including economics, engineering and any of the physical sciences.

The degree requirements for the Master of Mathematics in Computational Mathematics include six one-term (0.50 unit weight) graduate level courses and completion of a master's research paper (1.0 unit weight).
Master of Mathematics for Teachers (MMT)

Students are responsible for reviewing the General Information and Regulations section of the Graduate Studies Academic Calendar.

Program information

- **Admit term(s)**
  - Fall

- **Delivery mode(s)**
  - Online

- **Program type**
  - Master’s
  - Professional

- **Registration option(s)**
  - Part-time

- **Study option(s)**
  - Coursework

Admission requirements

- **Minimum requirements**
  - Four year Bachelors degree (or equivalent) in Mathematics, Mathematics Education, Science, Engineering, or a related discipline with a 75% average.
  - At least one year of prior work experience in education, with preference given to those actively teaching in mathematics, science, or computer science at the time of application.

- **Application materials**
  - Résumé
  - Transcript(s)

- **References**
  - Number of references: 2
  - Type of references: academic

- **English Language Proficiency Certification (ELPC) (if applicable)**

Degree requirements

- **Graduate Academic Integrity Module (Graduate AIM)**

- **Courses**
  - Students are required to complete the equivalent of 9 one-term (0.50 unit weight) graduate level courses including the completion of a capstone project (MATH 699 Master of
Mathematics for Teachers Capstone, 0.50 unit weight). The remaining courses are to be
MATH courses at the 600 and/or 700 level.

- MATH 600 and MATH 692 should be taken in a student's first term in the program.
- Each of these courses are offered online, with the exception of MATH 690, which is offered
  on-campus in Waterloo.
- MATH 699 Master of Mathematics for Teachers Capstone: the capstone project is designed to
give students an opportunity to showcase the knowledge that they have gained and to
provide a forum for bringing that knowledge into their own classroom. In most cases, with the
guidance of a faculty member, students will be asked to choose a mathematical concept or
area of study, perform all necessary background reading, and then design and complete a
project consisting of a short three week mini-course on the chosen topic that would be
accessible to their students and colleagues. To be successfully completed, the capstone
project must be approved by the student's capstone supervisor. Students can begin the
capstone requirement any time after they have completed the equivalent of 6 courses (0.50
unit weight).
- Students must maintain an overall average of 75% in the program, with individual course
  marks of at least 70%. Student performance will be assessed annually for progress towards
  the MMT degree.

Mathematics for Teachers website

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- The Master of Mathematics for Teachers (MMT) program is administered through the Centre for
  Education in Mathematics and Computing (CEMC). It is expected that students will normally take
  between two and five years to complete this part-time program.

- Certification of English language proficiency through one of the accepted examinations if you have not
  completed three or more years of post-secondary work at a Canadian institution, or at an institution
  at which English was the primary language of instruction, or have not been employed for a similar
  period of time in a position in which English was the primary language of business.

- Applications will be made to the CEMC, according to the usual procedures for the Faculty of
  Mathematics. The Admissions Committee of the MMT program will review applications and make
  appropriate recommendations. The Admissions Committee of the MMT program will determine the
  suitability of each applicant's background for success in this program.

- The program is targeted to students teaching at the secondary school or college level with a 4-year
  bachelor's degree in mathematics, mathematics education, science, engineering, or a related
  discipline with a strong mathematical background. Most applicants to the MMT program will have
  been away from formal schooling for several years.
Handling of Final Assessment Reports related to academic program reviews and follow-up Two-Year Progress Reports.

Introduction
Waterloo’s Senate Undergraduate Council (SUC) and Senate Graduate and Research Council (SGRC) have among other responsibilities, a fiduciary duty is to consider all aspects relating to the academic quality of undergraduate studies and graduate studies, respectively, within the university. As described in Waterloo’s Institutional Quality Assurance Process (IQAP), documentation emerging from the cyclical program review process includes: (1) a Final Assessment Report, which summarizes the self-study, external reviewers’ report, program response and implementation plan, and (2) a Two-Year Progress Report, which reports on progress related to the implementation plan. This document outlines a process for vetting these reports through SUC and SGRC.

Process
All undergraduate program reports are handled by SUC. Likewise, all graduate program reports are handled by SGRC. For augmented reports (combined undergraduate and graduate), in any given year, half will go through SUC and the other half through SGRC to share the workload.

For Final Assessment Reports two SUC or SGRC members will be asked to review the report. For Two-Year Progress Reports, one SUC or SGRC member will be asked to review the report, although at the SUC/SGRC Chair’s discretion, a second reviewer may be sought.

Reviewers of FAR and Two-year reports will consider a series of guiding questions (see below) in coming to their recommendation to SUC or SGRC. Furthermore, before reporting to SUC or SGRC, reviewers are encouraged to ask questions and share their observations as well as any concerns they have identified with the program under review (usually through the chair of the program). Any revisions should be completed by the chair of the program prior to bringing the report for approval at a SUC or SGRC meeting.

Guiding questions for Final Assessment Reports
Does the Final Assessment Report:
1) Identify the significant strengths and weaknesses of the program as described by either the program and/or the visiting team?

2) Include a credible implementation plan that not only addresses the substantive issues identified from the program review process but also identifies clearly:
   - What actions will follow from specific recommendations?
   - Who will be responsible for acting on those recommendations?
   - Who will be responsible for providing resources?
   - Priorities for implementation and realistic timelines for initiating and monitoring actions?
Guiding questions for Two-Year Progress Reports

Does the Two-Year Progress Report:

1) Clearly describe progress achieved on the various action items in the implementation plan?

2) Explain convincingly any circumstances that would have altered the original implementation plan?

3) For items that are behind schedule, propose an amended implementation schedule that is reasonable and credible?

4) Does the report address significant developments or initiatives that have arisen since the program review process, or that were not contemplated by the program review process?

Reviewers, should they request it, will be provided access to the confidential documents informing the reports (e.g. self study, reviewers’ report, program response), but consulting these documents is not expected unless there is a need to clarify some aspect of a Final Assessment Report or Two-Year Progress Report. All members of SUC and SGRC will have the opportunity to review the Final Assessment Report or Two-Year Progress Report ahead of the meeting in which the report will be considered and so will have the necessary information to engage in discussion.

To promote transparency and foster integrity in the review process, whenever possible, reviewers should not be members of the faculty/ Affiliated and Federated Institutions of Waterloo (AFIW) from which the reports originate.

Normally, the associate dean (undergraduate studies or graduate studies) in the faculty (or equivalent in an AFIW institution) where the program resides would be asked questions during an SUC or SGRC meeting when then report is being discussed. However, responses from any member of SUC or SGRC who can offer insight, are welcome. The department chair or school Director (or their chosen delegate) of the program being considered could be invited to attend the SUC or SGRC meeting by the associate dean to act as a resource person.

SUC’s and SGRC’s responsibility will be to focus on the overall credibility and feasibility of the report and the proposed plan of action – seeking to uncover, for example, unexplained disjunctions between the reviewers’ recommendations and the department’s response – as opposed to the minutiae of course content and curriculum structure.
**Meaning of Approval at SUC or SGRC**

For both Final Assessment Reports and Two-Year Progress Reports, SUC or SGRC should ultimately be able to assess whether the report is (a) satisfactory; (b) satisfactory but with minor concerns; or (c) unsatisfactory due to major concerns.

In considering whether to approve a Final Assessment Report, SUC or SGRC will focus on the above guiding questions for FARs or Two-Year Progress Reports.

For a Two-Year Progress Report, endorsement of the report by SUC or SGRC indicates that SUC/SGRC is satisfied with the progress to date on the implementation plan based on the answers to the guiding questions, and that SUC or SGRC has confidence that remaining action items will be appropriately addressed on the established timelines.

A Final Assessment Report or Two-Year Progress Report that is deemed “satisfactory” by a majority vote of SUC/SGRC will be submitted to Senate for information, normally without additional comment. Should the discussion at SUC or SGRC reveal issues of minor or major concern (as indicated by vote), SUC/SGRC shall forward the pertinent minutes of the meeting to the head of the program in question (and their resource person if one acted as their delegate) to advise of the concerns identified at SUC or SGRC and to invite a response which may include amendments to the original report, along with the appropriate endorsement by the faculty dean or AFIW head. The report then comes back to SUC or SGRC for reconsideration and a final vote. A report considered unsatisfactory is not forwarded to Senate, but is instead returned to the head of the program with a request for further work. A program chair at this stage may request an unsatisfactory report be provided to Senate, in which case Senate shall be provided the report with a description of the areas of concern identified.
Two Year Progress Report
Earth and Environmental Sciences
(BA/MA/PhD)
September 2015

Undergraduate Program:
The reviewers note that recruitment is generally an issue for Earth Science and Geology departments, and suggested several mechanisms to increase intake. Our undergraduate population has increased rapidly in recent years, from 156 students in 2012 to 268 students in 2014. These numbers represent Earth & Environmental Science students only and do not include students in Geological Engineering. We have managed to absorb this increase without compromising on quality of offerings, particularly with respect to experiential learning. Details follow.

Recommendation 1: It is recommended that the Department and the University explore opportunities for recruitment from the Ontario college system credit transfer agreement. Acceptance of transfer credits from colleges is now done routinely, but is not a major source of enrolment. During 2012 to 2014 we accepted 14 transfers into our programs from other universities and colleges.

We have instituted an agreement with the Waterloo Region District School Board and provide advanced standing for Earth Science 121 (Introduction to Earth Science) through a dual credit high school course (Earth and Space Science). In 2013/14, 53 students wrote the test to get the credit. However, none ended up registering for our programs.

Recommendation 2: It is recommended that the Department ensure alignment of minimum program requirements with APGO standards for professional registration, and communicate APGO standards clearly to students.

Our EES programs all meet APGO standards for accreditation, and APGO provides an information session to students on campus each fall as well as an informative website approved by APGO for University of Waterloo students. As well, we counsel students in related programs (mostly Environmental Science) on how to use their electives to qualify for APGO accreditation.
**Recommendation 3:** It is recommended that the Department ensure that all undergraduate courses are integrated, and that faculty undertake to maintain an ongoing process of collaborative course renewal that ensures continuity while eliminating gaps and redundancy. This is an ongoing process. We have instituted an annual teaching retreat as of 2015, and also annual meetings of people teaching in each of the three specializations for our Honours EES program to enhance information sharing with respect to teaching matters.

**Recommendation 4:** It is recommended that the Department undertake to expand opportunities for undergraduate students to engage in undergraduate thesis, co-operative work terms, or other research or employment experiences within the analytical research facilities.

Our EES program is offered in co-op format and 29% of our students elect to do a co-op degree. All of our EES programs require students to do either an undergraduate thesis (2 terms) or a project (1 term). Our research laboratories make extensive use of summer assistants from the undergraduate program, often but not always via the co-op program. On-line courses were discouraged by the reviewers, and we remain lightly invested in this form of course delivery although we are being encouraged to develop in this direction. Field trips and labs retain their prominence in our courses. We also subsidize students to attend the Prospectors and Developers Conference in Toronto each year, and as of last year we are sending a team to the World Mining Competition in Saskatoon.

**Recommendation 5:** It is recommended that the Geophysics Specialization be discontinued if no additional faculty expertise can be recruited to support the program.

This program continues to attract excellent students and held 24 students in 2014. The courses within the program are also very popular with our Geological Engineering students. We hesitate to cancel it for these two reasons. We are currently searching for a new Department Chair, and are in discussion with a senior faculty member (an NSERC IRC) from another university who wishes to move to our Department. Her group includes PhD-level geophysicists. In view of these opportunities to recruit new faculty, we wish to continue to offer the Geophysics Specialization.

**Recommendation 6:** It is recommended that the Geochemistry Specialization be discontinued.

This program is undersubscribed, but is in an area where we have considerable research strength and where we are mounting relevant courses that are well subscribed by students in other specializations. Until now the program has been run out of the Chemistry Department. We are in the process of rebuilding a Geochemistry offering based in Earth Sciences better suited to the needs of geochemists, and making it a specialization within Earth and Environmental Sciences.
Recommendation 7: It is recommend that the Department identify essential core areas of foundational earth sciences as priorities in recruitment of faculty.

Retirements had eroded our strength in core areas of Earth Science. Recent recruits of our Department (Chris Yakymchuk – petrology and economic geology; John Johnston – sedimentology and stratigraphy; Brian Kendall – sedimentary geochemistry and metal isotope geochemistry) have addressed this. As well, we have had discussions with adjunct faculty recently retired from the Geological Survey of Canada about stronger involvement in the undergraduate side of the Department.

Recommendation 8: We recommend expanding collaborative delivery of courses that meet the needs of both Geoscience and Ecology specializations within the Environmental Science program.

These two specializations have many courses in common, including a common first year. Thereafter, there are relatively few required Biology courses in the Geoscience specialization but ample opportunity for Biology electives in years 3&4. There are some Earth Science courses in the Ecology specialization, plus electives. We are about to enter discussions with Biology about a new joint Environmental Science specialization in Water Science, designed to be taught both here and in select Chinese universities in years 1 and 2. This discussion will also provide the opportunity for us increase our collaboration in teaching the Environmental Science program. However, we do wish to continue to provide students in all of the Environmental Science specializations the scope to pursue their particular interests rather than mandate the mix of courses.

Recommendation 9: It is recommended that all faculty be encouraged to take part in Honours Thesis supervision.

Our increased enrollment is putting a major strain on thesis and project courses. Getting more project supervisors remains a significant challenge that we must overcome. Options that we have discussed include, in order of preference: 1) strongly encouraging faculty participation; 2) increased use of research faculty and possibly postdoctoral fellows as supervisors; 3) formal assignment of a quota of students to faculty members; 4) using teaching assistants; 5) eliminating the requirement for a project and/or restricting access based on grades. It should be noted that very few faculty do not participate, and most take on several students at a time. For the indolent, forcing them to take undergrad students may not be in the best interests of the students or the advisors. The current problem is actually driven by increasing enrollment and decreased faculty numbers. The options listed above may not all be necessary to solve our problem, but the issue certainly has our attention at the moment.

Recommendation 10: It is recommended that the University Administration re-evaluate admission and student-preparation practices for the China-Canada 2+2 program.
It is an ongoing challenge to improve communication skills and provide experiential learning to the China 2+2 students. A major initiative we launched in this direction is Earth 10, a non-credit course that focuses on communications and problem solving. While created for 2+2 students, all students are welcome to participate in their first year at UW. The Earth 10 model is now being replicated by other Science departments. As well, all EES students are required to take an English or communication course as their Arts core elective. More generally, many Earth courses include oral and written assignments giving students opportunity to improve their communication skills as they learn.

Recommendation 11: It is recommended that the Department continue to build relationships with its alumni, develop mechanisms for more effectively gathering student feedback on degree completion, and create a means for tracking careers of alumni.

Earth Science has strong ongoing relationships with many of its alumni. There are annual alumni events (Farvolden Day, PDAC Alumni Reception). We do not have a staff person devoted to this task, but Faculty of Science has two individuals who coordinate interaction with alumni. We are re-instituting an exit survey for graduating students as of this year.

Graduate Program:
Since the last external review several actions have been taken, some of which are still underway, to remediate shortcomings and strengthen graduate training in the Department. Below we provide a follow-up response to the recommendations outlined in the External Reviewers’ Report.

Recommendation 12: Now is the time to realign graduate course offerings with the realities of existing departmental complement and expertise, and with desired student learning outcomes.

A purge of courses no longer offered was conducted in fall 2014. Three old courses are in the process of being deactivated and removed from the online list of courses. A total of five new graduate courses have also been added since. The graduate course offerings now better reflect the current expertise of the department.

Recommendation 13: It is recommended that the new graduate curriculum include a multidisciplinary “techniques” course that exposes students to diverse, advanced analytical techniques in the earth and environmental sciences.

The graduate committee considered this recommendation and found that, given the breadth of the department, targeted courses would be more appropriate. Some of these exist already (e.g., Earth 656, Groundwater Modelling; Earth 661, Analytical Methods; 671, Field Methods in Hydrogeology). We have added a course in Geographical Information Systems.
**Recommendation 14:** Graduate course delivery needs to be more equably distributed across the department.
Faculty in EES are expected to teach a graduate course annually, and this expectation is largely adhered to. We do not feel that the load is unfairly distributed at this time.

**Recommendation 15:** It should be absolutely a requirement that students meet with their complete supervisory committee within weeks of arrival, in order to lay out the necessary program of study, courses and research.
The Graduate Committee monitors students closely to ensure Committees are established within the recommended timelines at Waterloo and that committee meetings do occur at least once per year. Recent changes to the regular MSc program, such as the implementation of a formal thesis seminar course (Earth 695), is one new mechanism in place now to ensure committees are formed in the first two terms of a student’s program and that the thesis project, research plan, and courses are discussed in a timely manner.

**Recommendation 16:** It is recommended that the requirement for remedial undergraduate training in earth science be re-evaluated at this time in order to allow for consideration of the context of a student’s specific research plans, recognizing the increasingly interdisciplinary nature of earth science research and faculty specializations within the Department.
This is related to the previous recommendation, and although we agree that a student’s background needs to be reviewed in light of their research project at the first committee meeting, a meeting within weeks of arrival is impractical.

**Recommendation 17:** It is recommended that the graduate admissions processes be investigated, with a view to elimination of unnecessary procedures and inefficiencies, and to rapid turnaround of offers of admission.
Timely processing of graduate applications remains a concern to some of our faculty, and may occasionally result in the loss of good students. However, the main problems are not at the Department level and we continue to discuss solutions with the Associate Dean of Science for Graduate Studies. A Task Force on Graduate Recruiting submitted (2013) a number of recommendations to improve key strategic recruitment practices.

**Recommendation 18:** It is recommended that the Department place a high priority on preparing a new, comprehensive Graduate Student Handbook.
Such a handbook was prepared in September 2014 and it is given to all incoming graduate students and is available in pdf format on the department website. The plan was to update this document once per year to ensure it stays up to date. There have been no changes to programs and rules since 2014, however we plan to review everything before fall 2016 to ensure that the handbook is consistent with the current calendar. An additional initiative that is being
considered is to invite new graduate students twice a year (e.g., in September and January) to a meet and greet with the Graduate Committee and to run Q&A sessions about graduate studies.

**Recommendation 19: It is recommended that the Department foster awareness of instructional support services available at the UW, and work with the Centre for Teaching Excellence to create opportunities for graduate students to increase their instructional skills.**

The responsibility of communicating these services to graduate students is shared between Departments and the CTE itself. This is one of the things that could be discussed during the meet and greet with graduate students (cf. Rec 18 response). Another planned initiative is to send an email to all graduate students about the available resources and to encourage them to visit the graduate student page of the CTE for more information and to sign-up for their workshops. A separate email will be sent out to students on the TA list to remind them about these programs.
Date of next program review: 

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MEMORANDUM

February 22, 2016

TO: Mike Grivicic, Assistant University Secretary, Senate Graduate and Research Council

FROM: Heidi Mussar, Assistant Director, Graduate Financial Aid & Awards

RE: Agenda items for Senate Graduate & Research Council – March 2016

Items for Approval

a) Bruce Mitchell Graduate Scholarship – endowment

A scholarship valued at $1,500 will be awarded annually to a graduate student registered full-time in the first year of either a Master’s or Doctoral program in the Department of Geography and Environmental Management in the Faculty of Environment at the University of Waterloo. The Department of Geography and Environmental Management will select a recipient annually based on academic excellence. Eligible candidates must be conducting research in the area of Environment and Resource Management. This fund is made possible by donations from friends and family of Dr. Bruce Mitchell, in honour of his outstanding career at the University of Waterloo.

This award is funded via $25,000 from the donor plus gifts already received from friends and family totalling $50,000.

b) T.H. Sze Memorial Award – endowment

This award was originally established around 1992 but no agreement could be found. New terms of reference were written up in November 2015 by the Department of Civil & Environmental Engineering. Donations of $12,000 have been received; with CPI adjustments over the past 20 years, the total principal is just over $20,000.

One award valued at $500 will be awarded annually to a graduate student registered in the MASc or PhD program in the Department of Civil & Environmental Engineering in the Faculty of Engineering at the University of Waterloo who is conducting research in the field of experimental stress analysis. The purpose of the award is to assist students with student salaries, material and/or labor costs, travel expenses, conference fees, etc. as related to their research. Interested students must complete an application found on the Department of Civil & Environmental Engineering website by November 1.

This award was established by Dr. Yulun Sze in memory of his father to encourage research intended to repair and rehabilitate the aging infrastructure of our cities.

c) Neelanjana Pal Memorial Scholarship – trust

A scholarship valued at $3,250 will be awarded annually to a full-time graduate student registered in year 2 of the Master’s program in Electrical & Computer Engineering in the Faculty of Engineering. Selection will be based on academic excellence (minimum cumulative average of 80%) and a demonstrated interest in the area of community development. Interested students should submit an application to the Department of Electrical & Computer Engineering by July 30. This fund is made possible by a donation from Neelanjana Pal’s family in her honour.
The goal is that the gift of $13,000 being donated in March 2016, will fund one award valued at $3,250 annually for four years.

d) **Certificate in University Teaching (CUT) Award - operating**  
*Originally approved at SG&RC in December 2004, funding for this award has been provided by an anonymous donor up until 2015. Funding is now being provided by an operating account managed by the Graduate Studies Office.*

**Original Award Description:**

**PUBLICATION DESCRIPTION**

The **Certificate in University Teaching Award** is given annually to a graduate student who demonstrates the highest achievement upon completion of this certificate program. Selection will be made by the Director of Centre for Teaching Excellence. The recipient of the award will be recognized at an appropriate event as determined by the CTE office.

This award is open to all graduate students enrolled in the Certificate in University Teaching Program.

**New Award Description:**
The Certificate in University Teaching (CUT) Award honours a graduate student who shows a strong commitment to their development as a university teacher and demonstrates the highest achievement on completion of the CUT program. Jointly administered by the Centre for Teaching Excellence (CTE) and the Graduate Studies Office (GSO), this award also publicly recognizes the importance and value of teaching development efforts by Waterloo’s graduate students who, through their various instructional roles, contribute to the quality of undergraduate education at Waterloo. Funding for this annual award is provided by the Graduate Studies Office.

**Items for Information**

e) **Stantec Graduate Scholarship in Civil Engineering – trust**

*Previously approved at SG&RC in February 2011, the award is being renewed for 5 years with an annual gift of $3,000 beginning in 2016. The value of the annual award is being reduced from $4,000 to $3,000 under the new terms.*

**Existing Award Description:**
A scholarship, valued at $4,000, is presented annually for 5 years to an outstanding student entering the first year of a postgraduate program in the Department of Civil Engineering. This award was established by Stantec in recognition of the on-going contribution of Stantec to engineering in Canada, and Stantec’s commitment to graduate education.

**New Award Description:**
An award, valued at approximately $3000 is awarded annually to a full-time graduate student enrolled in Year One of the Masters/Doctoral program in the Department of Civil Engineering in the Faculty of Engineering who has demonstrated academic excellence and research potential. Consideration will be given to Stantec employees and their immediate family. This fund is made possible by a donation from Stantec.

f) **Three Minute Thesis (3MT) Competition: First Place Award and Runner Up Award – operating**

*Previously approved at SG&RC in February 2013, the award is no longer being funded through the Graduate Student Endowment Fund (GSEF) but rather from a Graduate Studies Office operating account. The values and description remain the same as originally approved.*
Award Description:
The Three Minute Thesis (3MT) competition is an annual university-wide competition for research-based master’s and doctoral students at the University of Waterloo. Competitors have one static slide and three minutes to explain the breadth and significance of their research to a non-specialist audience. Winners of the First Place and Runner Up Award will be selected by a panel of judges at the university-wide 3MT final competition. The First Place winner will receive an award of $1,000 and the Runner Up will receive an award of $500.