Faculty of Mathematics

Waterloo
Faculty of Mathematics

About the Faculty of Mathematics

Overview of Faculty
The Faculty of Mathematics consists of the Departments of Applied Mathematics, Combinatorics and Optimization, Pure Mathematics, and Statistics and Actuarial Science, and the David R. Cheriton School of Computer Science. The Faculty offers a four-year honours program leading to the degree Bachelor of Mathematics (BMath) in fields of study corresponding to each of the Departments and the School, as well as in Computational Mathematics, Mathematical Studies, Mathematics/Business, Mathematics/Chartered Accountancy, and Mathematics/Financial Analysis and Risk Management. The Faculty also offers a four-year honours program leading to the degree Bachelor of Computer Science (BCS). In co-operation with the Faculty of Engineering, the Mathematics Faculty offers a program leading to the degree Bachelor of Software Engineering (BSE). In co-operation with the Faculty of Arts, the Mathematics Faculty offers a four-year honours program in Computing and Financial Management (BCFM). In co-operation with the Faculty of Science, the Mathematics Faculty offers a four-year honours program in Bioinformatics leading either to the BCS or Bachelor of Science (BSc).

The Faculty also offers graduate programs leading to the following degrees: Master of Mathematics (MMath) and Doctor of Philosophy (PhD). Detailed information is contained in the University of Waterloo Graduate Studies Calendar.

Admission
Admission requirements and procedures for all plans are described in the "Admissions" section.

Most students are admitted directly from secondary school. However, students who are enrolled in another faculty in the University of Waterloo, or at another university, may apply to transfer to the Faculty of Mathematics. Applicants should have strong academic records. (See "Transfer Students" for additional policies concerning transfer students and transfer credits.) In addition, a student who has been away from formal education for more than two years may apply as a mature student. Although the University of Waterloo does not automatically offer admission to mature applicants, the Admissions Committee carefully considers previous academic records, resumes, and other biographical material before determining a candidate's suitability for university studies. You must be able to demonstrate recent academic proficiency in Mathematics at the senior high school level. For applicants who are lacking the appropriate background, the Centre for Extended Learning offers online courses in Algebra & Geometry and Calculus.

Access to Programs, Plans, and Courses
Practical circumstance, such as significant budget shortfalls or the unavailability of qualified personnel, may result in restrictions in the choices available to students as compared with those listed herein or in other University publications. The University reserves the right to limit access to courses or programs/plans, and, at its discretion, to withdraw particular programs, plans/sub plans/options/minors, or courses altogether. In the event that existing resources make it necessary to limit admission to a plan, sub plan, option or minor, the admission process will be based on competition for the spaces available.

University of Waterloo – Undergraduate Research Internship (UW – URI)
For details, please refer to Undergraduate Research Internship.

Recognition of Excellence
Recognition of Excellence
Alumni Gold Medal
An alumni Gold Medal is presented annually, usually at spring convocation, to recognize the academic excellence of the Math Faculty's most outstanding undergraduate student.

K.D. Fryer Gold Medal
The K.D. Fryer Gold Medal is presented annually, at fall convocation, to a graduating Math student who best exemplifies academic excellence and good student citizenship.

Graduating "With Distinction – Dean's Honours List"
In recognition of outstanding academic records throughout their undergraduate careers, all students who graduate with a Honours BCS or BMath degree, and have a cumulative average (CAV) of at least 87%, and do not have any INC, IP, or UR grades are eligible to graduate "With Distinction – Dean's Honours List." In addition to having this notation appear on their official University transcripts and diplomas, such students have their names displayed in gold in the Math Faculty Colloquium Room (MC 5158).

Graduating "With Distinction"
In recognition of distinguished academic achievement throughout their undergraduate careers, all students who graduate with a Honours BCS or BMath degree, either four-year honours or three-year general, and a cumulative average (CAV) of at least 80%, and do not have any INC, IP, or UR grades are eligible to graduate "With Distinction." This notation appears on official University transcripts and diplomas.

Term Dean's Honours List
In recognition of outstanding academic achievement in an academic term, the designation "Term Dean's Honours List" is awarded to undergraduate
Math students who satisfy all of the following criteria for the term:

- registered in an honours plan with a term average (TAV) of at least 87%, normally this average must be based on numeric or letter grades in at least 2.5 units;
- no excluded courses;
- no INC, IP, or UR grades.

J. Alan George Award
The J. Alan George Award is presented annually, at the Math Graduation Ball, to a graduating Math student who best exemplifies student leadership and dedicated involvement in student affairs on campus for the benefit of Math students.

List of Academic Programs/Plans

Co-op vs. Regular
Most of the Faculty’s plans are available in both the regular (conventional September to April academic year) and co-operative (alternating four-month academic and work terms) systems of study. Plans that are offered only for co-op students are explicitly indicated in the list of plans below.

Students in the regular system of study normally take courses during the fall and winter terms.

Honours BMath Academic Plans
The Faculty offers the following honours plans leading to a BMath degree through the five departments:

- Actuarial Science
- Actuarial Science/Finance Option
- Applied Mathematics
- Applied Mathematics/Biology Option
- Applied Mathematics/Earth Sciences Option
- Applied Mathematics/Economics Option
- Applied Mathematics/Physics Option
- Applied Mathematics with Engineering Electives (co-op only)
- Combinatorics and Optimization
- Computational Mathematics
- Computational Mathematics/Bio-Medical Option
- Computational Mathematics/Data-Mining Option
- Computational Mathematics/Earth and Space Option
- Computational Mathematics/Economics Option
- Computer Science
- Computer Science/Business Option
- Computer Science/Digital Hardware Option (co-op only)
- Mathematical Finance
- Mathematical Physics
- Operations Research
- Pure Mathematics
- Pure Mathematics with Electrical Engineering Electives (co-op only)
- Pure Mathematics/Teaching Option (co-op only)
- Scientific Computation/Applied Mathematics
- Statistics
- Statistics for Health

A subcommittee of Combinatorics and Optimization, Computer Science, and Statistics and Actuarial Science administers the following plans leading to a BMath degree:

- Information Technology Management
- Mathematical Economics
- Mathematics/Business Administration – Economics Option
- Mathematics/Business Administration – Human Resources Management Option
- Mathematics/Chartered Accountancy – Actuarial Science Option (co-op only)
- Mathematics/Chartered Accountancy – Finance Option (co-op only)
- Mathematics/Chartered Accountancy – Information Systems Management Option (co-op only)
- Mathematics/Financial Analysis and Risk Management - Professional Risk Management Specialization
The Dean's Office administers the following three plans leading to a BMath degree:

- Mathematics/Teaching Option (co-op only)
- Mathematical Studies
- Mathematical Studies - Business Specialization

Honours BCS Academic Plans
Through the David R. Cheriton School of Computer Science, the Faculty offers the following honours plans leading to a BCS degree:

- Computer Science
- Computer Science/Bioinformatics Option
- Computer Science/Business Option
- Computer Science/Digital Hardware Option (co-op only)
- Computer Science/Software Engineering Option

Double Degree Academic Plans
The School of Business and Economics at Wilfrid Laurier University (WLU) and the Faculty of Mathematics at the University of Waterloo (UW) offer the following plan which leads to a Honours BBA degree from WLU and a Honours BMath degree from UW.

- Business Administration and Mathematics (co-op only)

The School of Business and Economics at Wilfrid Laurier University (WLU) and the David R. Cheriton School of Computer Science at the University of Waterloo (UW) offer the following plan which leads to a Honours BBA degree from WLU and a Honours BCS degree from UW.

- Business Administration and Computer Science (co-op only)

Honours BSc Academic Plans
The Faculty of Science and the David R. Cheriton School of Computer Science offer the following honours plans leading to a BSc degree:

- Bioinformatics
- Biology and Bioinformatics

Honours Computer Science and Financial Management
The BCFM Steering Committee administers this program which leads to the BCFM degree. The committee consists of faculty from the David R. Cheriton School of Computer Science in the Faculty of Mathematics and the School of Accounting and Finance in the Faculty of Arts.

- Computing and Financial Management (co-op only)

Honours Software Engineering
The Software Engineering Program Board administers this program, which leads to the BSE degree. The board consists of faculty from the David R. Cheriton School of Computer Science in the Faculty of Mathematics and from the Department of Electrical and Computer Engineering in the Faculty of Engineering.

- Software Engineering (co-op only)

Admission to Specific Honours Academic Plans

Admission to Specific Honours Academic Plans
At any time prior to their 3A term, honours students in good standing within the Faculty will be eligible for admission to the plan of their choice, subject to the limitations below. It is understood, however, that academic advisors will continue to recommend that a student consider an alternative if they feel the student is inadequately prepared for the chosen plan.

1. CS major plans include: all plans leading to the BCS degree; the Computer Science plan, Computer Science/Business Option, and the Computer Science/Digital Hardware Option leading to the BMath degree; the Honours Bioinformatics and Honours Biology and Bioinformatics plans leading to the BSc degree; and all Joint or Double Honours BMath plans involving Computer Science as one of the explicitly designated major areas of study. The Honours Software Engineering plan is also considered a Computer Science major plan for the purpose of student access to Computer Science courses, but admission and continuation are handled separately.

It is expected that admission to Computer Science major plans will normally occur when a student first applies to the Faculty of Mathematics.

For a detailed description of transferring into Computer Science, please see the Computer Science admission requirements section.

3. With the exceptions of Applied Mathematics/Engineering Electives, all Computer Science major plans, Computational Mathematics, Financial Analysis and Risk Management, Information Technology Management, Mathematics/Business Administration, Mathematics/Chartered Accountancy, and the Business Administration and Mathematics Double Degree plans, students are not admitted to specific honours plans prior to Year Two.

4. Enrolment in Software Engineering (BSE) degree studies is restricted and students must normally be admitted to this program in Year One.

5. Actuarial Science is a restricted-enrolment plan. Admission to Actuarial Science requires a major average of at least 70%. A student with no major average will be admitted with a cumulative average of at least 70% on at least ten non-excluded courses, provided they have no more than one failed or excluded course.

In the 3A term and beyond, admission to specific honours plans is at the discretion of the major Department(s) or Dean's Office as appropriate.

BCS and BMath Academic Plan Combinations, Convocation Programs, Diplomas, and Transcripts

Students pursuing a BCS or BMath degree may enrol in as many as three academic plans, subject to the limitations specified below. Students must enrol in at least one such plan. Multiple-plan combinations sometimes require more than 40 courses (20.0 units) and/or more than the customary eight study terms to satisfy all of the various plan requirements.

Enrolment is restricted to at most three potential academic plans. These plans must appear in a predetermined order as prescribed below, and they are denoted as plan 10, plan 20, and plan 30 respectively.

All of the requirements of this section also apply to the set of plans that appear on a student's diploma, convocation program, and transcript. If a graduating student has met all the requirements for more than three plans, then for each plan after the third one, text will be added to the student's transcript to reflect the additional plans.

Eligible Plan Categories (in plan-sequencing priority order – top highest, bottom lowest)

1. “Stand-Alone” Math Faculty Honours plans (e.g., Pure Mathematics; Mathematical Financial Analysis and Risk Management/Chartered Financial Analyst Specialization; Applied Mathematics/Economics Option)
2. Math Faculty Joint Honours plans (BCS or BMath) for Math Faculty students (e.g., Joint Actuarial Science; Joint Combinatorics and Optimization)
3. External Joint Honours plans that academic units in other faculties have chosen to make available to Math Faculty students (e.g., Joint Psychology)
4. Math Faculty minors or options for Math Faculty students (e.g., Statistics Minor; Health Informatics Option)
5. External minors or options that academic units in other faculties have chosen to make available to Math Faculty students (e.g., French Minor; Management Studies Option)

Plan 10 is required and must be chosen from category 1 or category 2 plans above. If plan 10 is a category 1 plan, additional plans are optional. However, if plan 10 is a category 2 plan, it must be accompanied by a plan 20.

If plan 10 is a category 2 BCS plan, then plan 20 must be a category 2 or category 3 plan. If plan 10 is a category 2 BMath plan, then plan 20 must be a category 2 plan (see Joint Honours Academic Plans – BMath below).

A graduating student will receive a BMath degree if plan 10 is a BMath plan, and will receive a BCS degree if plan 10 is a BCS plan.

Restrictions on Plan Sequencing Order for Multiple-Plan Combinations

The BBA/BMath Double Degree plan, any Mathematics/Chartered Accountancy plan, or any BCS plan may only appear as plan 10, overriding any other ordering criteria for plan sequencing outlined below.

Subject to the overriding stipulation above:

1. If a student's plans belong in different plan categories, then the plan sequencing priority order above determines which plan comes earlier in the plan sequence. [e.g., plan 10 = Actuarial Science (category 1), plan 20 = Statistics Minor (category 4), plan 30 = Cognitive Science Option (category 5)].
2. If two or three of a student’s plans belong in the same category above, then alphabetical ordering of the plan names determines which plan comes earlier in the plan sequence.  [e.g., plan 10 = Actuarial Science/Finance Option, plan 20 = Mathematical Finance, both of which are category 1 plans].

Restrictions on Multiple-Plan Combinations

1. A category 1 BMath plan may not be combined with any BCS plan.
2. With the exception of Mathematical Finance which can be combined with another Actuarial Science plan and/or another Pure Mathematics plan, each Math Faculty plan in the combination must be chosen from a different group of plans on the following list:

   All plans offered by Actuarial Science
   All plans offered by Applied Mathematics
   All plans offered by Combinatorics and Optimization (including Operations Research)
   All plans offered by Computational Mathematics
   All plans offered by Computer Science
   All plans offered by Pure Mathematics
   All plans offered by Statistics
   All Math/Business plans (refer to “Academic/Plans” for complete list)
   Mathematics/Teaching Option
   Mathematical Studies

Specific Invalid Multiple-Plan Combinations

1. BBA/BCS or BBA/BMath with any plan similar to one appearing on the student’s WLU academic record transcript.
2. BCS/Business Option or BMath (Computer Science)/Business Option with a minor or option in Economics, Human Resources Management, or Management Studies.
3. Any Bioinformatics plan with any other plan offered by the Biology Department.
4. Applied Mathematics/Biology Option with any plan offered by the Biology Department.
5. Applied Mathematics/Earth Sciences Option with any plan offered by the Earth and Environmental Sciences Department.
6. Applied Mathematics/Economics Option with any plan offered by the Economics Department.
7. Applied Mathematics/Physics Option with any plan offered by the Physics Department.
8. Computational Mathematics/Bio-Medical Option with any plan offered by the Biology Department.
9. Computational Mathematics/Earth and Space Option with any plan offered by the Earth and Environmental Sciences or Physics Departments.
11. Information Technology Management with a Computer Science Minor.
12. Mathematical Economics with any other plan offered by the Economics Department.
13. Mathematical Physics with any other plan offered by the Physics Department.
14. Mathematical Studies (with or without a Business Specialization) with any other category 1 or category 2 plan.
15. Mathematical Studies/Business Specialization with a Management Studies Option or Minor.

Joint Honours Academic Plans - BMath only

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

Academic Plans and Requirements

Degree Requirements for all Math students

Degree Requirements for all Math students

Table I – Degree Requirements Common To All BCS, BCFM, and BMath Academic Plans

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Four-Year Honours Plans</th>
<th>Double Degree Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Co-op</td>
<td>Regular</td>
</tr>
<tr>
<td>Minimum course units (excluding PD courses and co-op work-term courses)</td>
<td>20**</td>
<td>20</td>
</tr>
<tr>
<td>Requirements</td>
<td>Four-Year Honours Plans</td>
<td>Double Degree Plans</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Minimum co-op work-term course units</td>
<td>2.5***</td>
<td>2</td>
</tr>
<tr>
<td>Minimum PD course units</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Minimum work reports</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Minimum math units</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td>Minimum non-math units</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>Minimum Cumulative Average (CAV)</td>
<td>60%</td>
<td>60%</td>
</tr>
<tr>
<td>Minimum Major Average (MAV) All AMATH and PMATH plans, including Mathematical Finance and Mathematical Physics</td>
<td>65%</td>
<td>not applicable</td>
</tr>
<tr>
<td>Minimum Major Average (MAV) ACTSC plans</td>
<td>70%</td>
<td>not applicable</td>
</tr>
<tr>
<td>Minimum Major Average (MAV) All other plans</td>
<td>60%</td>
<td>60%</td>
</tr>
<tr>
<td>Maximum excluded/failed course units (excluding PD courses and co-op work-term courses)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Maximum allowed units of course attempts (excluding PD courses and co-op work-term courses)</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td>Minimum number of full-time terms</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Minimum number of full-time terms</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>English Writing Skills</td>
<td>All BCS and BMath degree candidates must satisfy an English Writing Skills Requirement. See below.</td>
<td></td>
</tr>
</tbody>
</table>

*The Double Degree regular plan is for WLU-registered students only.

**The minimum course units for the Chartered Accountancy and Bioinformatics plans are 21 and 20.75, respectively.

*** The minimum co-op work term course units for the Chartered Accountancy and Teaching Option plans are 2.0.

The terms used in Table I are explained below.

**Math courses** – Courses with one of these prefixes: ACTSC (Actuarial Science), AMATH (Applied Mathematics), CO (Combinatorics and Optimization), CM (Computational Mathematics), CS (Computer Science), MATH (non-departmental Faculty courses), PMATH (Pure Mathematics), and STAT (Statistics). Any course that is cross-listed with a course having one of these prefixes is also considered a math course, regardless of the label under which it is taken. The following courses, with content very similar to courses offered in the Mathematics Faculty, are also considered to be math courses: ECE 222, 354, 428; SE 212/112, 240, 382, 463, 464, 465. Every math course is worth 0.5 units.

**Non-math courses** – Courses with the prefix COMM, MTHEL, and those courses offered by other faculties (excluding courses cross-listed with math courses and courses listed above as math courses). Work-term courses (COOP 1 to COOP 6) and professional development (PD) courses do not count as math or non-math courses.

**Major Average** – See sections 2 and 4 in "Faculty Policies."

**Cumulative Average** – See sections 1 and 3 in "Faculty Policies."

**Course Attempt** – Any course enrolment for which a student is assigned a final grade (including a grade of WD). Transfer credits from other institutions are also considered to be course attempts.

**Excluded Course** – A course which has been excluded is not included in any unit counts toward degree completion or in averages but is included in course attempts. Any failed course must be excluded, but a student may also choose to exclude a course with a passing grade below 60 (such a request must be made no more than six months after the grade appears in Quest). An excluded passed course normally cannot be used to meet any degree requirement or to meet the prerequisite requirements for another course.

**Full-time Term** – A term in which a student is enrolled in at least 1.5 course-attempt units.

**Unit** – The credit value associated with any course. All courses offered in the Faculty of Mathematics have a value of 0.5 units.

**Co-op Requirements**

As specified in Table I, co-op students are required to complete a minimum of five Professional Development courses. PD 1 must be taken in the term prior to the first work term and PD 2 must be taken during the first work term. At least one other Professional Development course must cover non-technical skills. With the exception of PD 1, these courses are normally taken during co-op work terms. Students are required to take a professional-development course each work term until the requirement is completed.

Co-op students must submit a work report following every work term until they have completed four acceptable work reports. Successful completion of PD 2 meets the requirement for a first work report.

**First-Year English Writing Skills Requirement**

All students in the Faculty of Mathematics must satisfy the following Writing Skills Requirement before enrolling in their 2B term:

- A grade of 60 or better on the UW English Language Proficiency Exam (ELPE), or
- Successfully complete the study program offered by the UW Writing Centre, or
- Complete one of the following courses with a grade of at least 60%:
Notes

1. Students who have written and failed ELPE should enrol in the Writing Centre or enrol in one of the above courses rather than attempt ELPE again.
2. Transfer credit for any of the above courses does not satisfy this requirement; the courses must be taken at the University of Waterloo.
3. Students who arrange a special sitting of the ELPE outside the scheduled dates will be assessed an administrative charge.
4. Students who have not completed the Writing Skills Requirement before enrolling in their 2B term will have their future registrations cancelled and will be allowed to proceed only after successful completion of this requirement.
5. A completed English Proficiency milestone on a student’s academic record will indicate successful completion of this requirement.
6. Students in the Software Engineering program must satisfy this requirement as set down by the Faculty of Engineering.
7. Students in the Computing and Financial Management program must satisfy this requirement as set down by the Faculty of Arts.

No-Credit/Overlap Courses

There are some restrictions on course selection for obtaining credit toward a BCS, BCFM, or BMath degree. Before enrolling in a course, students should check the Faculty of Mathematics "No-Credit List" and "Course Overlap List" to determine whether or not the course will count towards their BCS, BCFM, or BMath degree. See section 13.4 in "Faculty Policies" for further details.

Table II – Required Faculty Core Courses – Honours BMath Plans except Mathematical Studies and Mathematics/Chartered Accountancy

All of

<table>
<thead>
<tr>
<th>MATH 106 Applied Linear Algebra 1 or MATH 136 Linear Algebra 1 for Honours Mathematics</th>
<th>MATH 146 Linear Algebra 1 (Advanced Level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 127 Calculus 1 for the Sciences</td>
<td>MATH 137 Calculus 1 for Honours Mathematics</td>
</tr>
<tr>
<td>MATH 128 Calculus 2 for the Sciences</td>
<td>MATH 138 Calculus 2 for Honours Mathematics</td>
</tr>
<tr>
<td>MATH 135 Algebra for Honours Mathematics</td>
<td>MATH 145 Algebra (Advanced Level)</td>
</tr>
<tr>
<td>MATH 235 Linear Algebra 2 for Honours Mathematics</td>
<td>MATH 245 Linear Algebra 2 (Advanced Level)</td>
</tr>
<tr>
<td>STAT 230 Probability or STAT 240 Probability (Advanced Level)</td>
<td></td>
</tr>
<tr>
<td>STAT 231 Statistics or STAT 241 Statistics (Advanced Level)</td>
<td></td>
</tr>
</tbody>
</table>

One of

| CS 115 Introduction to Computer Science 1 |
| CS 135 Designing Functional Programs |
| CS 230 Introduction to Computers and Computer Systems |
| CS 234 Data Types and Structures |
| CS 241 Foundations of Sequential Programs |

One of

| CS 116 Introduction to Computer Science 2 |
| CS 136 Elementary Algorithm Design and Data Abstraction |
| CS 145 Design, Abstraction, and Implementation |

One of

<table>
<thead>
<tr>
<th>MATH 237 Calculus 3 for Honours Mathematics</th>
<th>MATH 247 Calculus 3 (Advanced Level)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 239 Introduction to Combinatorics</td>
<td>MATH 249 Introduction to Combinatorics (Advanced Level)</td>
</tr>
</tbody>
</table>

Notes

1. Refer to individual plan requirements to determine which of MATH 237 (or MATH 247) or MATH 239 (or MATH 249) is required for your plan. Some plans require both courses.
2. CS majors normally start in CS 115. Students with strong aptitude may take CS 145 followed by one of CS 230, 234, or 241. Students starting with CS 115 who wish access to CS major courses must take CS 136 after CS 116.
3. The three algebra and three calculus courses are normally taken in sequence in the 1A, 1B, and 2A terms. The two STAT courses are normally taken in the 2A and 2B terms.
4. Table II applies only to students enrolled in plans leading to the BMath degree, not any other degrees offered through the Faculty of Mathematics. Most requirements in Table II apply to Mathematics/Chartered Accountancy (MATH 235/245 is an exception). A full set of course requirements is given with the Chartered Accountancy plan.

Responsibility For Meeting Degree Requirements

Students are responsible for being aware of all regulations pertaining to their academic plans. This responsibility includes submitting a completed "Intention to Graduate - Undergraduate Studies" form to the Registrar’s Office (by the designated date for submission of such forms) during their last academic study term (i.e., the term in which they anticipate completing the requirements for their degree).

Incompatibility of Full-time Study with Full-time Employment

Students who by choice or necessity work on non-academic activities more than 10 hours per week should, where possible, structure their course/work load so that they can attend fully to their academic obligations. The Standings and Promotions (S&P) Committee will not normally grant petitions based on time pressure resulting from employment.

Honours Fallback Provision

Students who satisfy all of the following conditions may elect to graduate with a three-year BMath General Regular degree:

   a) Minimum of 15.0 total units passed  
   b) Minimum of 5.0 non-math units passed  
   c) Maximum of 25.0 units of course attempts  
   d) Maximum of 4.0 units excluded  
   e) A minimum cumulative average (CAV) of 60%  
   f) Minimum 8.0 math units including the following courses passed

One of

CS 115 Introduction to Computer Science 1
CS 135 Designing Functional Programs
CS 230 Introduction to Computers and Computer Systems
CS 234 Data Types and Structures
CS 241 Foundations of Sequential Programs

One of

CS 116 Introduction to Computer Science 2
CS 136 Elementary Algorithm Design and Data Abstraction
CS 145 Design, Abstraction, and Implementation

All of

MATH 106 Applied Linear Algebra 1 or MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)
MATH 127 Calculus 1 for the Sciences or MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)
MATH 128 Calculus 2 for the Sciences or MATH 138 Calculus 2 for Honours Mathematics or MATH 148 Calculus 2 (Advanced Level)
MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
MATH 225 Applied Linear Algebra 2 or MATH 235 Linear Algebra 2 for Honours Mathematics or MATH 245 Linear Algebra 2 (Advanced Level)
STAT 220 Probability (Non-Specialist Level) or STAT 230 Probability or STAT 240 Probability (Advanced Level)
STAT 221 Statistics (Non-Specialist Level) or STAT 231 Statistics or STAT 241 Statistics (Advanced Level)

One of

MATH 207 Calculus 3 (Non-Specialist Level) or MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
MATH 229 Introduction to Combinatorics (Non-Specialist Level) or MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)

Note

As a general practice, it is not intended that a student be awarded a General BMath degree, and then subsequently be awarded an Honours BMath degree. Students who request, and are granted, a general degree will be deemed to have withdrawn from the Math Faculty, and thus are ineligible for further BMath degree studies. Such students may petition to the Standings and Promotions (S&P) Committee for re-admission to an honours plan, but such petitions will normally be considered only after an absence from the Faculty of several terms.
Actuarial Science

Actuarial Science Overview
The Department of Statistics and Actuarial Science offers courses and plans in Actuarial Science, which is the application of mathematics and statistics to financial problems with particular emphasis on life insurance, casualty insurance, and employee benefit programs. The courses offered provide theoretical preparation for the courses of the Society of Actuaries and the Casualty Actuarial Society, and include studies of such subject areas as Mathematics of Finance, Life Contingencies, Risk Theory, and Casualty Ratemaking. Note: Students in Honours Actuarial Science and Honours Actuarial Science/Finance Option require a major average (MAV) of 70% to remain eligible to continue in their plan.

By carefully selecting their non-math courses, students can also gain valuable background knowledge in economics, finance, administration, and law.

Actuarial Science
In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 26 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- ACTSC 231 Mathematics of Finance
- ACTSC 232 Introduction to Actuarial Mathematics
- ACTSC 331 Life Contingencies 1
- ACTSC 371 Corporate Finance 1
- ACTSC 431 Loss Models 1
- ACTSC 432 Loss Models 2
- ECON 101 Introduction to Microeconomics
- ECON 102 Introduction to Macroeconomics
- ENGL 119 Communications in Mathematics & Computer Science
- STAT 330 Mathematical Statistics
- STAT 331 Applied Linear Models
- STAT 333 Applied Probability
- STAT 340 Computer Simulation of Complex Systems

Four additional courses chosen from

- Any 300- or 400-level ACTSC course
- AFM 472 Investments
- STAT 431 Generalized Linear Models and their Applications
- STAT 443 Forecasting

One of

- MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
- AMATH 231 Calculus 4
- AMATH 250 Introduction to Differential Equations

Two additional 300- level or 400-level math courses.

Actuarial Science/Finance Option
In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 26 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

One of

- MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
- AMATH 231 Calculus 4
- AMATH 250 Introduction to Differential Equations

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- ACTSC 231 Mathematics of Finance
ACTSC 232 Introduction to Actuarial Mathematics
ACTSC 331 Life Contingencies 1
ACTSC 371 Corporate Finance 1
ACTSC 372 Corporate Finance 2
ACTSC 431 Loss Models 1
ACTSC 445 Asset-Liability Management
ACTSC/STAT 446 Mathematical Models in Finance
AFM 101 Introduction to Financial Accounting
AFM 102 Introduction to Managerial Accounting
ECON 101 Introduction to Microeconomics
ECON 102 Introduction to Macroeconomics
ENGL 119 Communications in Mathematics & Computer Science
STAT 330 Mathematical Statistics
STAT 331 Applied Linear Models
STAT 333 Applied Probability
STAT 340 Computer Simulation of Complex Systems

Four additional courses chosen from

Any 300- or 400-level ACTSC course
AFM 472 Investments
STAT 433 Stochastic Processes
STAT 443 Forecasting

Joint Actuarial Science

See "BCS and BMath Academic Plan Combinations" for a description of joint plan requirements. Note that both specialization areas designated in such joint plans must be disciplines within the Faculty of Mathematics. Note that at least 28 math courses are required.

All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
ACTSC 231 Mathematics of Finance
ACTSC 232 Introduction to Actuarial Mathematics
ACTSC 331 Life Contingencies 1
ACTSC 431 Loss Models 1
ACTSC 432 Loss Models 2
STAT 330 Mathematical Statistics
STAT 333 Applied Probability

Three additional courses chosen from

Any 300- or 400-level ACTSC course
AFM 472 Investments
STAT 331 Applied Linear Models
STAT 340 Computer Simulation of Complex Systems
STAT 431 Generalized Linear Models and their Applications
STAT 443 Forecasting

Mathematical Finance

The Mathematical Finance plan is offered jointly by the Departments of Statistics and Actuarial Science and of Pure Mathematics.

In conjunction with the common degree requirements in "Table I in "Degree Requirements, this plan requires at least 26 math courses. These overall requirements must include the Faculty core courses outlined in "Table II in "Degree Requirements" and the following courses:

All of

MATH 247 Calculus 3 (Advanced Level) or MATH 237 Calculus 3 for Honours Mathematics*
AFM 101 Introduction to Financial Accounting
AFM 102 Introduction to Managerial Accounting
AFM 131/ARBUS 101 Introduction to Business in North America
ACTSC 231 Mathematics of Finance
ACTSC 371 Corporate Finance 1
One of

- AMATH 351 Ordinary Differential Equations 2
- CO 250/CM 340 Introduction to Optimization
- CO 352 Computational Optimization
- PMATH 352 Complex Analysis

One of

- AMATH 353 Partial Differential Equations 1
- AMATH 432/PMATH 453 Functional Analysis
- CO 372 Portfolio Optimization Models
- CM/CS 476 Numeric Computation for Financial Modeling

Note

MATH 147 and 148 provide highly desirable background for students in the Mathematical Finance plan.

Actuarial Science Minor

This minor is only open to students within the Faculty of Mathematics.

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- ACTSC 231 Mathematics of Finance
- ACTSC 232 Introduction to Actuarial Mathematics
- ACTSC 331 Life Contingencies 1
- ACTSC 431 Loss Models 1
- STAT 330 Mathematical Statistics
- STAT 333 Applied Probability

One additional 300- or 400-level ACTSC course.

Applied Mathematics

Applied Mathematics Overview

Applied Mathematics is motivated mathematics, or mathematics to a purpose. It reflects the belief that there exists a basic order and harmony in the universe which may be described by the logical structures of mathematics. Thus, it is no coincidence that some of the greatest mathematicians of the past were also interested in engineering and physics.

This rich, classical tradition of Applied Mathematics is typified by the ongoing work in Theoretical and Fluid Mechanics, General Relativity, and Quantum Theory, at the interface among Mathematics, Theoretical Physics, and Engineering, and covering such diverse areas as the study of supersonic flow, the behaviour of ocean waves, the structure of space-time and cosmology, and the fundamental symmetry properties of the world of atoms and molecules. In addition, newer areas, such as Control Theory and Signal/Image Processing, analyze processes ranging from optimal control of a space vehicle to the coding, compression and transmission of signals and images. As scientists find out more and more about the
mechanisms that make the world "tick," we also find that more, often new, mathematics is necessary to systematize, digest, and take advantage of
this wealth of knowledge in all scientific areas. This need is often reflected in a keen interest among applied mathematicians in ordinary and partial
differential equations and their discretizations.

In their first two years, all Applied Mathematics students take the same core courses as are taken by other Mathematics students, in order to acquire
a sound mathematical background. At the same time, since the application of analytical reasoning to a wide variety of problems is the essence of
Applied Mathematics, there is room for courses in scientific disciplines which are heavy users of mathematics, such as Physics or Engineering. In the
upper years, the focus is on courses more specifically related to their chosen area of specialization. It is our experience that Applied Mathematics
graduates find their career opportunities to be excellent and varied.

Applied Mathematics

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 26 math courses. These overall
requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 237</td>
<td>Calculus 3 for Honours Mathematics or MATH 247</td>
</tr>
<tr>
<td>AMATH 231</td>
<td>Calculus 4</td>
</tr>
<tr>
<td>AMATH 242/CM 271/CS 371</td>
<td>Introduction to Computational Mathematics</td>
</tr>
<tr>
<td>AMATH 250</td>
<td>Introduction to Differential Equations</td>
</tr>
<tr>
<td>AMATH 261/PHYS 263</td>
<td>Classical Mechanics and Special Relativity</td>
</tr>
<tr>
<td>AMATH/PMATH 332</td>
<td>Applied Complex Analysis</td>
</tr>
<tr>
<td>AMATH 351</td>
<td>Ordinary Differential Equations 2</td>
</tr>
<tr>
<td>AMATH 353</td>
<td>Partial Differential Equations 1</td>
</tr>
</tbody>
</table>

Three 400-level AMATH courses.

Two additional 300- or 400-level AMATH courses.

All of

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 121</td>
<td>Mechanics and Waves 1</td>
</tr>
<tr>
<td>PHYS 122</td>
<td>Mechanics and Waves 2</td>
</tr>
</tbody>
</table>

Recommended course

AMATH/PMATH 331 Applied Real Analysis

Joint Applied Mathematics

See "BCS and BMath Academic Plan Combinations" for a description of joint plan requirements. Note that both specialization areas designated in such
joint plans must be disciplines within the Faculty of Mathematics.

All of

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATH 237</td>
<td>Calculus 3 for Honours Mathematics or MATH 247</td>
</tr>
<tr>
<td>AMATH 231</td>
<td>Calculus 4</td>
</tr>
<tr>
<td>AMATH 242/CM 271/CS 371</td>
<td>Introduction to Computational Mathematics</td>
</tr>
<tr>
<td>AMATH 250</td>
<td>Introduction to Differential Equations</td>
</tr>
<tr>
<td>AMATH 261/PHYS 263</td>
<td>Classical Mechanics and Special Relativity</td>
</tr>
<tr>
<td>AMATH/PMATH 332</td>
<td>Applied Complex Analysis</td>
</tr>
<tr>
<td>AMATH 351</td>
<td>Ordinary Differential Equations 2</td>
</tr>
<tr>
<td>AMATH 353</td>
<td>Partial Differential Equations 1</td>
</tr>
</tbody>
</table>

Three 400-level AMATH courses.

All of

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>PHYS 121</td>
<td>Mechanics and Waves 1</td>
</tr>
<tr>
<td>PHYS 122</td>
<td>Mechanics and Waves 2</td>
</tr>
</tbody>
</table>

Recommended course

AMATH/PMATH 331 Applied Real Analysis

Applied Mathematics/Biology Option

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan has the same course requirements as Honours
Applied Mathematics, with the following constraint on the applied mathematics courses:
All of

AMATH/BIOL 382/CM 353 Computational Modeling of Cellular Systems

The following courses are required in the non-math component of the plan:
All of

BIOL 130 Introductory Cell Biology
BIOL 139 Genetics

An additional 2.5 units of BIOL courses at least 1.5 units of which are at the 300- or 400-level.

Applied Mathematics/Earth Science Option
In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan has the same course requirements as Honours Applied Mathematics with the following constraint on the mathematics courses:
All of

AMATH 361 Continuum Mechanics
AMATH 463 Fluid Mechanics

The following courses are required in the non-math component of the plan:
All of

EARTH 121 Introductory Earth Sciences
EARTH 122 Introductory Environmental Sciences

An additional 2.5 units of EARTH courses at least 1.5 units of which are at the 300- or 400-level.

Applied Mathematics/Economics Option
In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan has the same course requirements as Honours Applied Mathematics with the following constraint on the mathematics courses:
One of

CO 250/CM 340 Introduction to Optimization
CO 355 Mathematical Optimization

The following courses are required in the non-math component of the plan:
All of

ECON 101 Introduction to Microeconomics
ECON 102 Introduction to Macroeconomics
ECON 201 Microeconomic Theory 1
ECON 202 Macroeconomic Theory 1

An additional 1.5 units of 300- or 400-level ECON courses.

Applied Mathematics/Physics Option
In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan has the same course requirements as Honours Applied Mathematics, with the following additional courses required in the non-math component of the plan:
All of

PHYS 234 Quantum Physics 1
PHYS 241 Electricity and Magnetism
PHYS 258 Thermal Physics
PHYS 359 Statistical Mechanics

An additional 1.5 units of PHYS courses at least 1.0 units of which are at the 300- or 400-level.

Applied Mathematics with Engineering Electives (co-op only)
Enrolment in this plan is limited; a cumulative average of 70% or higher is strongly recommended. Students must choose one of two specializations
In order to introduce a non-technical component into the plan, it is required that 2.5 units be chosen from outside the Mathematics, Science, and Engineering faculties.

a) Fluids and Heat

In conjunction with the common degree requirements Table I in "Degree Requirements," this plan has the same course requirements as Applied Mathematics, with the following constraints on the mathematics courses:

All of

AMATH 342/CM 352 Computational Methods for Differential Equations
AMATH 361 Continuum Mechanics
AMATH 463 Fluid Mechanics

One of

CO 250/CM 340 Introduction to Optimization
CO 355 Mathematical Optimization
CO 367/CM 442 Nonlinear Optimization
STAT 331 Applied Linear Models
STAT 340 Computer Simulation of Complex Systems

The following courses are required in the non-math component of the plan:

All of

GENE 123 Electrical Engineering or ME 123 Electrical Engineering for Mechanical Engineers
ME 219 Mechanics of Deformable Solids 1
ME 250 Thermodynamics 1
ME 353 Heat Transfer 1
ME 354 Thermodynamics 2
ME 456 Heat Transfer 2

One of

ME 557 Combustion 1
ME 564 Aerodynamics
ME 571 Air Pollution

b) Communication and Control

In conjunction with the common degree requirements Table I in "Degree Requirements," this plan has the same course requirements as Applied Mathematics, with the following constraints on the mathematics courses:

All of

AMATH 342/CM 352 Computational Methods for Differential Equations
AMATH 455 Control Theory

One of

CO 250/CM 340 Introduction to Optimization
CO 355 Mathematical Optimization
CO 367/CM 442 Nonlinear Optimization
CM 375/CS 475 Computational Linear Algebra
STAT 331 Applied Linear Models
STAT 340 Computer Simulation of Complex Systems

The following courses are required in the non-math component of the plan:

All of

GENE 123 Electrical Engineering or ME 123 Electrical Engineering for Mechanical Engineers
ECE 207 Signals and Systems
ECE 240 Electronic Circuits 1
Two of

- ECE 411 Digital Communications
- ECE 412 Coded Digital Communications
- ECE 413 Digital Signal Processing
- ECE 484 Digital Control Applications
- ECE 486 Robot Dynamics and Control
- SYDE 372 Introduction to Pattern Recognition
- SYDE 444 Biomedical Measurement and Signal Processing

Mathematical Physics

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 20 math courses. The overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- AMATH 231 Calculus 4
- AMATH 242/CM 271/CS 371 Introduction to Computational Mathematics
- AMATH 250 Introduction to Differential Equations
- AMATH 261/PHYS 263 Classical Mechanics and Special Relativity
- AMATH/PMATH 332 Applied Complex Analysis
- AMATH 351 Ordinary Differential Equations 2
- AMATH 353 Partial Differential Equations 1
- AMATH 373 Quantum Theory 1 or PHYS 334 Quantum Physics 2
- PHYS 121 Mechanics and Waves 1
- PHYS 122 Mechanics and Waves 2
- PHYS 234 Quantum Physics 1
- PHYS 241 Electricity and Magnetism
- PHYS 258 Thermal Physics
- PHYS 359 Statistical Mechanics
- PHYS 363 Intermediate Classical Mechanics
- PHYS 441A Electromagnetic Theory

Three of

- AMATH/PMATH 331 Applied Real Analysis
- AMATH 361 Continuum Mechanics
- AMATH 432/PMATH 453 Functional Analysis
- AMATH 456 Calculus of Variations
- AMATH 463 Fluid Mechanics
- AMATH 473/PHYS 454 Quantum Theory 2
- AMATH 475/PHYS 476 Introduction to General Relativity

Three of

- AMATH 473/PHYS 454 Quantum Theory 2
- AMATH 475/PHYS 476 Introduction to General Relativity
- CO 481/CS/PHYS 467 Introduction to Quantum Information Processing
- PHYS 335 Condensed Matter Physics
- PHYS 434 Quantum Physics 3
- PHYS 435 Solid State Physics
- PHYS 441B Electromagnetic Theory
- PHYS 444 Modern Particle Physics
- PHYS 480 Radiation Biophysics

2.5 units of electives chosen from outside the Mathematics, Science, and Engineering faculties.
Scientific Computation/Applied Mathematics

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 26 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- AMATH 231 Calculus 4
- AMATH 242/CM 271/CS 371 Introduction to Computational Mathematics
- AMATH 250 Introduction to Differential Equations
- AMATH 342/CM 352 Computational Methods for Differential Equations
- AMATH 351 Ordinary Differential Equations 2
- AMATH 353 Partial Differential Equations 1
- CM 375/CS 475 Computational Linear Algebra
- CS 230 Introduction to Computers and Computer Systems
- CS 234 Data Types and Structures
- STAT 331 Applied Linear Models

One of

- AMATH/PMATH 331 Applied Real Analysis
- AMATH/PMATH 332 Applied Complex Analysis

One of

- CO 250/CM 340 Introduction to Optimization
- CO 355 Mathematical Optimization

Two of

- AMATH 442/CM 452 Computational Methods for Partial Differential Equations
- AMATH 444/CM 454 Applications of Computational Differential Equations
- AMATH 447/CM 433/CS 487 Introduction to Symbolic Computation
- AMATH 453 Partial Differential Equations 2
- AMATH 455 Control Theory
- AMATH 456 Calculus of Variations
- AMATH 463 Fluid Mechanics
- AMATH 473/PHYS 454 Quantum Theory 2
- CO 453 Network Design
- CO 459 Topics in Optimization
- CO 463 Convex Optimization and Analysis
- CO 466 Continuous Optimization
- CM 461/STAT 440 Computational Inference
- CM 463/STAT 441 Statistical Learning - Classification

Note: Many of the courses on this list have prerequisites that are not plan requirements.

Two additional math courses.

At least five courses (2.5 units) from one of the following departments:

- any one Engineering department
- any one Science department
- Economics

Note: Engineering courses may not be open to Mathematics students or may not easily fit schedules.

Other course concentrations may be taken with the approval of the Applied Mathematics Undergraduate Officer.

Applied Mathematics Minor
This minor is only open to students within the Faculty of Mathematics.

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- AMATH 231 Calculus 4
Combinatorics and Optimization including Operations Research

Combinatorics and Optimization Overview
Combinatorics is the study of discrete structures and their properties. It includes coding theory, combinatorial design, enumeration theory, graph theory, and polyhedral theory. Many modern scientific advances have employed combinatorial structures to model the physical world, and recent advances in computational technology have made such investigations feasible. In particular, since computers process discrete data, combinatorics has become indispensable to computer science.

Optimization, or mathematical programming, is the study of maximizing and minimizing functions subject to specified boundary conditions or constraints. The functions to be optimized arise in engineering, the physical and management sciences, and in various branches of mathematics. With the emergence of computers, optimization experienced a dramatic growth as a mathematical theory, enhancing both combinatorics and classical analysis. In its applications to engineering and management sciences, optimization forms an important part of the discipline of operations research.

Both combinatorics and optimization have long been special interests of Canadian mathematicians. Indeed, Waterloo was the first university in the world to have a Department of Combinatorics and Optimization, and it continues to be a leading centre for teaching and research in the theories and applications of these disciplines.

Combinatorics and Optimization
In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 26 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

\[
\text{MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)}
\]

One of

\[
\text{CO 250/CM 340 Introduction to Optimization}
\text{CO 355 Mathematical Optimization}
\]

One of

\[
\text{CO 330 Combinatorial Enumeration}
\text{CO 342 Introduction to Graph Theory}
\]

One of

\[
\text{CO 351 Network Flow Theory}
\text{CO 367/CM 442 Nonlinear Optimization}
\text{(If CO 355 is taken, this requirement can be satisfied by taking one of CO 450-471.)}
\]

Three additional courses chosen from

\[
\text{CO 330 Combinatorial Enumeration}
\text{CO 331 Coding Theory}
\text{CO 342 Introduction to Graph Theory}
\text{CO 351 Network Flow Theory}
\text{CO 355 Mathematical Optimization}
\text{CO 367/CM 442 Nonlinear Optimization}
\text{CO 430-487, excluding CO 480}
\]

All of

\[
\text{PMATH 336 Introduction to Group Theory with Applications}
\]

Three of

\[
\text{MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)}
\]
AMATH/PMATH 331 Applied Real Analysis
AMATH/PMATH 332 Applied Complex Analysis
AMATH 447/CM 433/CS 487 Introduction to Symbolic Computation
CS 462 Formal Languages and Parsing
CS 466 Algorithm Design and Analysis
PMATH 334 Introduction to Rings and Fields with Applications
PMATH 340 Elementary Number Theory

Note: Except for CM/CS 472, these fourth-year CS courses are open only to CS majors.

Two additional 300- or 400-level math courses with a course prefix other than CO.
One additional 300- or 400-level math course.

Joint Combinatorics and Optimization
See "BCS and BMath Academic Plan Combinations" for a description of joint plan requirements. Note that both specialization areas designated in such joint plans must be disciplines within the Faculty of Mathematics.

All of

MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)

One of

CO 250/CM 340 Introduction to Optimization
CO 355 Mathematical Optimization

Four additional courses chosen from

CO 330 Combinatorial Enumeration
CO 331 Coding Theory
CO 342 Introduction to Graph Theory
CO 351 Network Flow Theory
CO 355 Mathematical Optimization
CO 367/CM 442 Nonlinear Optimization
CO 430-487, excluding CO 480

All of

PMATH 336 Introduction to Group Theory with Applications

Three of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
AMATH/PMATH 331 Applied Real Analysis
AMATH/PMATH 332 Applied Complex Analysis
CM 339/CS 341 Algorithms
CS 360 Introduction to the Theory of Computing
CS 466 Algorithm Design and Analysis
PMATH 334 Introduction to Rings and Fields with Applications
PMATH 340 Elementary Number Theory

Note: CS 466 is open only to CS joint majors.

Combinatorics and Optimization Minor
This minor is only open to students within the Faculty of Mathematics.

All of

MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)

One of

CO 250/CM 340 Introduction to Optimization
CO 355 Mathematical Optimization
One of

CO 330 Combinatorial Enumeration
CO 342 Introduction to Graph Theory

Two additional courses chosen from

CO 330 Combinatorial Enumeration
CO 331 Coding Theory
CO 342 Introduction to Graph Theory
CO 351 Network Flow Theory
CO 367/CM 442 Nonlinear Optimization
CO 430-487, excluding CO 480

Operations Research Overview
Operations Research is the field of mathematics that deals with the problems of management in business and government. It involves constructing mathematical models of complex real world situations and then applying sophisticated techniques to these models in order to make optimal, or near optimal, decisions. The three major components of the discipline of Operations Research are Optimization, Statistics, and Computer Science.

The honours plan in Operations Research combines a solid foundation in mathematics with special sequences of courses in economics, business, and management science. The mathematics portion of the plan includes linear programming, modeling, scheduling, forecasting, decision theory, and computer simulation.

In Canada, employers of Operations Research graduates are found in manufacturing, distribution, and retail companies, mining, transportation, banking, health services, education, and government agencies. Students proceeding to a Master’s of Business Administration degree (MBA) find that a degree in mathematics, emphasizing Operations Research, together with relevant work-term experience, is an excellent preparation for a rewarding career.

Operations Research
In conjunction with the common degree requirements in Table I in “Degree Requirements,” this plan requires at least 26 math courses. These overall requirements must include the Faculty core courses outlined in Table II in “Degree Requirements” and the following courses:

One of

CD 250/CM 340 Introduction to Optimization
CD 355 Mathematical Optimization

All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
MATH 239/349 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
AMATH 242/CM 271/CS 371 Introduction to Computational Mathematics or CS 370 Numerical Computation
CD 351 Network Flow Theory
CD 370/CM 443 Deterministic OR Models
CS 234 Data Types and Structures
CS 330 Management Information Systems or CS 490 Information Systems Management
STAT 331 Applied Linear Models
STAT 333 Applied Probability
STAT 340 Computer Simulation of Complex Systems
(if CD 355 is taken, one of CD 450-471 may be taken instead of CO 351.)

Four of

AMATH 250 Introduction to Differential Equations
CD 342 Introduction to Graph Theory
CD 367/CM 442 Nonlinear Optimization
CD 372 Portfolio Optimization Models
CD 450 Combinatorial Optimization
CD 452 Integer Programming
CD 453 Network Design
CD 454 Scheduling
CD 456 Introduction to Game Theory
CD 463 Convex Optimization and Analysis
CO 466 Continuous Optimization
CO 471 Semidefinite Optimization
CO 487/CM 432 Applied Cryptography
CS 338 Computer Applications in Business: Databases
CS 430 Applications Software Engineering
CS 432 Business Systems Analysis
STAT 332 Sampling and Experimental Design
STAT 433 Stochastic Processes
STAT 435 Statistical Methods for Process Improvements
STAT 443 Forecasting

All of

AFM 101 Introduction to Financial Accounting
ECON 101 Introduction to Microeconomics
MSCI 211 Organizational Behaviour

Two of

AFM 102 Introduction to Managerial Accounting
ECON 102 Introduction to Macroeconomics
MSCI 311 Organizational Design and Technology
MSCI 432 Production and Service Operations Management

Recommended

ARBUS 302/ECON 344 Marketing: Principles of Marketing and Consumer Economics
BUS 352W Introduction to Marketing Management
SPCOM 223 Public Speaking
(BUS 352W is offered by Wilfrid Laurier's School of Business and Economics.)

Students enrolled in a double honours plan in Computer Science and Operations Research must replace the Computer Science courses listed above with the equivalent courses required by Honours Computer Science major students.

Computational Mathematics

Computational Mathematics Overview
Mathematical models arise in a wide variety of fields: business, economics, engineering, finance, medicine, science, and many others. The application of computer methods to simulate such models was traditionally called "scientific computation," though the practice has spread far beyond its roots in science to encompass problems arising in all areas of society. The results of such simulations are numerical answers, formulae, data sets, plots, charts, and images that help us to understand the nature of the world around us, and allow us to predict and influence the future. Developing and analyzing such models involves a blend of mathematics and computer science. It includes issues such as the implications of finite precision arithmetic, the efficiency, accuracy, and stability of numerical computations, the development and maintenance of mathematical software, and the effects of modern developments in computer architectures and networks. Graduates of Computational Mathematics will be able to deploy effectively a wide range of mathematical and computational techniques in areas of application.

Computational Mathematics

In conjunction with the common degree requirements in Table I in "Degree Requirements," all Honours Computational Mathematics plans requires at least 26 math courses. Students not taking CS 115 or 135 must complete one additional 300- or 400-level math course. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
CM 271/AMATH 242/CS 371 Introduction to Computational Mathematics
CS 230 Introduction to Computers and Computer Systems or CS 241 Foundations of Sequential Programs
CS 234 Data Types and Structures or CS 240 Data Structures and Data Management

Four of the following "core" courses

CM 339/CS 341 Algorithms
CM 340/CD 250 Introduction to Optimization
Additional requirements for each separate plan are described below.

Notes:

1. Students doing a minor in Economics may use the CM mathematics course requirements from either Honours Computational Mathematics or from Honours Computational Mathematics/Economics Option.
2. Students doing a minor in Biology may use the CM mathematics course requirements from either Honours Computational Mathematics or from Honours Computational Mathematics/Bio-Medical Option.
3. Students doing a minor in Physics or Earth Sciences may use the CM mathematics course requirements from either Honours Computational Mathematics or from Honours Computational Mathematics/Earth and Space Option.

Honours Computational Mathematics
Four additional courses, two from each of two course lists below:

Discrete Mathematical Algorithms

CM 432/CD 487 Applied Cryptography
CM 433/AMATH 447/CS 487 Introduction to Symbolic Computation
CM/PMATH 434 Techniques in Computational Number Theory
CD 456 Introduction to Game Theory
CD 485 The Mathematics of Public-Key Cryptography
CS 456 Algorithm Design and Analysis
CS 482 Computational Techniques in Biological Sequence Analysis

Computational Optimization

CM 441/CD 353 Computational Discrete Optimization
CM 442/CD 367 Nonlinear Optimization
CM 443/CD 370 Deterministic OR Models
CD 372 Portfolio Optimization Models
CD 450 Combinatorial Optimization
CD 452 Integer Programming
CD 454 Scheduling

Methods for Scientific Computing

CM 353/AMATH/BIOL 382 Computational Modeling of Cellular Systems
CM 452/AMATH 442 Computational Methods for Partial Differential Equations
CM/CS 473 Medical Image Processing
CM/CS 476 Numerical Computation for Financial Modeling
CS 483 Computational Techniques in Structural Bioinformatics

Computational Statistics and Data Analysis

CM 461/STAT 440 Computational Inference
CM 462/STAT 442 Data Visualization
CM 463/STAT 441 Statistical Learning - Classification
CM 464/STAT 444 Statistical Learning - Function Estimation

Three (1.5 units) non-math courses in an area of application of computational mathematics. At least one of these three courses must be at the 200-, 300-, or 400-level. These courses must be approved by a Computational Mathematics advisor.

Computational Mathematics/Bio-Medical Option
The four "core" courses selected must include:

CM 352/AMATH 342 Computational Methods for Differential Equations
CM 361/STAT 341 Computational Statistics and Data Analysis
CM 375/CS 475 Computational Linear Algebra
In addition, the following courses are required:

Three of

- CM 353/AMATH/BIOL 382 Computational Modeling of Cellular Systems
- CM 452/AMATH 442 Computational Methods for Partial Differential Equations
- CM 462/STAT 442 Data Visualization
- CM 463/STAT 441 Statistical Learning – Classification
- CM/CS 473 Medical Image Processing
- CS 482 Computational Techniques in Biological Sequence Analysis
- CS 483 Computational Techniques in Structural Bioinformatics

One additional 400-level CM course.

Seven of

- BIOL 110 Introductory Zoology
- BIOL 130 Introductory Cell Biology
- BIOL 139 Genetics
- BIOL 140 Fundamentals of Microbiology
- BIOL 208 Analytical Methods in Molecular Biology
- BIOL 211 Introductory Vertebrate Zoology
- BIOL 241 Introduction to Applied Microbiology
- BIOL 250 Organismal and Evolutionary Ecology
- BIOL 273 Principles of Human Physiology 1
- BIOL 308 Principles of Molecular Biology
- BIOL 365 Resources in Bioinformatics
- BIOL 366 Introduction to Bioinformatics
- BIOL 370 Comparative Animal Physiology 1
- BIOL 371 Comparative Animal Physiology 2
- BIOL 373 Principles of Human Physiology 2
- BIOL 428 Plant Molecular Genetics
- BIOL 431 Bacterial Molecular Genetics
- BIOL 434 Human Molecular Genetics
- BIOL 441 Immunology
- BIOL 444 Microorganisms and Disease
- BIOL 449 Public Health Microbiology
- BIOL 452 Quantitative Fisheries Biology
- BIOL 456 Population Biology

Note: Of these courses, at least three must be at the 300- or 400-level.

Computational Mathematics/Data-Mining Option

The four "core" courses selected must include:

- CM 339/CS 341 Algorithms
- CM 340/CD 250 Introduction to Optimization
- CM 361/STAT 341 Computational Statistics and Data Analysis

In addition, the following courses are required:

All of

- CM 461/STAT 440 Computational Inference
- CM 462/STAT 442 Data Visualization
- CM 463/STAT 441 Statistical Learning – Classification
- CM 464/STAT 444 Statistical Learning – Function Estimation

Two of

- CM 442/CD 367 Nonlinear Optimization
- CS 348 Introduction to Database Management
- CS 486 Introduction to Artificial Intelligence
Either three (1.5 units) non-math courses in each of two areas of application of data-mining, or six courses in a single area of application. Of these
at least one must be at the 300- or 400-level. These courses must be approved by a Computational Mathematics advisor.

Computational Mathematics/Earth and Space Option
The four "core" courses selected must include:

CM 352/AMATH 342 Computational Methods for Differential Equations
CM 375/CS 475 Computational Linear Algebra

In addition, the following courses are required:

One of

AMATH 231 Calculus 4
AMATH 250 Introduction to Differential Equations

All of

CM 452/AMATH 442 Computational Methods for Partial Differential Equations

Three additional 400-level CM courses.

Seven of

AMATH 261/PHYS 263 Classical Mechanics and Special Relativity
AMATH 361 Continuum Mechanics
AMATH 475/PHYS 476 Introduction to General Relativity
EARTH 121 Introductory Earth Sciences
EARTH 122 Introductory Environmental Sciences
EARTH 123 Introductory Hydrology
EARTH 223 Hydrology
EARTH 260 Applied Geophysics 1
EARTH 359 Flow Through Porous Media
EARTH 361 Atmospheric Motions and Physics
EARTH 458 Physical Hydrogeology
EARTH 460 Applied Geophysics 2
EARTH 461 Applied Geophysics 3
PHYS 121 Mechanics and Waves 1
PHYS 122 Mechanics and Waves 2
PHYS 222 Electricity and Magnetism 1
PHYS 258 Thermal Physics
PHYS 275 Astrophysics 1 – The Solar System
PHYS 375 Astrophysics 2 – Stars and Stellar Evolution
PHYS 475 Astrophysics 3 – Galaxies and Cosmology

Note: Of these courses, at least three must be at the 300- or 400-level.

Computational Mathematics/Economics Option
The four "core" courses selected must include:

CM 340/CD 250 Introduction to Optimization
CM 352/AMATH 342 Computational Methods for Differential Equations
CM 361/STAT 341 Computational Statistics and Data Analysis

In addition, the following courses are required:

All of

CM 375/CS 475 Computational Linear Algebra
CM 452/AMATH 442 Computational Methods for Partial Differential Equations
CM 461/STAT 440 Computational Inference

One of

CM/CS 476 Numerical Computation for Financial Modeling
One additional 400-level CM course.

All of

- ECON 101 Introduction to Microeconomics
- ECON 102 Introduction to Macroeconomics
- ECON 201 Microeconomic Theory 1
- ECON 202 Macroeconomic Theory 1
- STAT 331 Applied Linear Models

One of

- ECON 403 Topics in Economic Forecasting
- ECON 405 Quantitative Finance
- ECON 422 Topics in Econometrics

Note: Some of the courses on this list have prerequisites that are not plan requirements.

Two (2.0 units) additional ECON courses at the 300- or 400-level.

Note: ACTSC 371 may be used in place of one of these additional ECON courses at the 300- or 400-level.

Computational Mathematics Minor

This minor is only available to students within the Faculty of Mathematics.

One of

- CM 271/AMATH 242/CS 371 Introduction to Computational Mathematics
- CS 370 Numerical Computation

Three of

- CM 339/CS 341 Algorithms
- CM 340/CO 250 Introduction to Optimization
- CM 352/AMATH 342 Computational Methods for Differential Equations
- CM 361/STAT 341 Computational Statistics and Data Analysis
- CM 375/CS 475 Computational Linear Algebra

Three additional 300- or 400-level CM courses.

At most three of these seven courses may also be used to satisfy an explicit choice list course requirement of the student’s major. For CS majors, at most three of the seven can have (or be cross-listed with course having) a CS label.

Computer Science

Computer Science Overview

Computer Science is centred around the study of information. It is concerned with the nature and properties of information, its structure and classification, its storage and retrieval, and the various types of processing to which it can be subjected. It is also concerned with the physical machines that perform these operations, with the elemental units of which these machines are composed, with the organization of these units into efficient information processing systems, and with the exploration of the limits of the abilities of these machines.

Computer Science is recognized as an independent discipline with an inherently mathematical nature. Its activity ranges from theoretical areas such as the theory of automata, system organization and logic design, formal languages and computability theory to applied areas such as scientific computing, programming languages, bioinformatics, software management, and computer systems.

The advent of the computer has facilitated a systems approach to solving many problems in science, business, and industry. There is currently a great demand for information analysts to define how systems will perform these functions and for programmers to implement production systems on computers.

The following regular and co-operative plans are accredited by the Computer Science Accreditation Council, which is sponsored by the Canadian Information Processing Society (www.cips.ca).

- BMath Honours Computer Science
- BMath Honours Computer Science/Business Option
• BMath Honours Computer Science/Digital Hardware Option
• Honours Bachelor of Computer Science
• Honours Bachelor of Computer Science/Business Option
• Honours Bachelor of Computer Science/Digital Hardware Option
• Honours Bachelor of Computer Science/Software Engineering Option
• Any double Honours plan involving an accredited Computer Science plan
• Any accredited Computer Science plan with a minor

Plans involving the Software Engineering Option are also accredited under the Software Engineering criteria.

This accreditation recognizes that the quality of these plans meets published, generally accepted criteria for sound education in the discipline. A student who graduates from an accredited plan is eligible to be designated as an Information Systems Professional (www.cips.ca/standards) after two years of professional level experience.

Accreditation for Bioinformatics and plans involving Joint Honours Computer Science has not been sought.

Computer Science Major Plans
CS major plans include: all plans leading to the BCS degree; the Computer Science plan, Computer Science/Business Option, and the Computer Science/Digital Hardware Option leading to the BMath degree; the Honours Bioinformatics and Honours Biology and Bioinformatics plans leading to the BSc degree; and all Joint or Double Honours BMath plans involving Computer Science as one of the explicitly designated major areas of study. The Honours Computing and Financial Management program and the Honours Software Engineering program are also considered Computer Science major plans for the purpose of student access to Computer Science courses, but admission and continuation are handled separately.

It is expected that admission to Computer Science major plans will normally occur when a student first applies to the Faculty of Mathematics.

Students from within the Faculty of Mathematics with advanced standing may apply for admission to a Computer Science major plan if they:

• have completed at least one term in the Faculty of Mathematics with a typical course load for a Computer Science major. (For students taking a first-year CS course, a typical load includes one CS course, two math courses, and two non-math electives. For students taking second-year CS courses, a typical load includes two CS courses, two math courses, and one non-math elective.)
• have credit for CS 134, or 136, or 145
• have a Cumulative Mathematics Average of at least 65% (calculated over all math and computer science courses) and a CS major average of at least 70%

Advanced standing students from within the Faculty satisfying these conditions are normally admitted; applicants without some of these conditions will be considered on an individual basis. Students are normally not considered for admission beyond the 2B level.

Bachelor of Computer Science
This plan is subject to the common degree requirements in Table I in “Degree Requirements.”

One of

CS 115 Introduction to Computer Science 1
CS 135 Designing Functional Programs
A 300- or 400-level CS major course in addition to those required below

One of

CS 136 Elementary Algorithm Design and Data Abstraction
CS 145 Design, Abstraction, and Implementation

All of

MATH 127 Calculus 1 for the Sciences or MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)
MATH 128 Calculus 2 for the Sciences or MATH 138 Calculus 2 for Honours Mathematics or MATH 148 Calculus 2 (Advanced Level)
MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)
MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
STAT 230 Probability or STAT 240 Probability (Advanced Level)
STAT 231 Statistics or STAT 241 Statistics (Advanced Level)
CM 339/CS 341 Algorithms
CS 240 Data Structures and Data Management
CS 241 Foundations of Sequential Programs
CS 245 Logic and Computation
CS 246 Software Abstraction and Specification
CS 251 Computer Organization and Design
Three additional CS courses chosen from CS 340-398, 440-489.

Two additional CS courses chosen from CS 440-489.

One additional course chosen from

- CS 487 / CM 432: Applied Cryptography
- CM 461 / STAT 440: Computational Inference
- CS 440-498
- CS 499T: Honours Thesis
- CS 500- or 700-level courses

(CS 600- or 700-level courses may be taken only if an equivalent 400-level course does not exist and special permission is obtained from the instructor and a CS undergraduate advisor. Courses in this list may be counted as CS 0.5 units.)

The selection of upper-year CS courses must include at least one course from each of at least two of the following area groups:

- Systems and SE: CS 343, 349, 442, 444, 445, 446, 447, 450, 452, 454, 456, 457, 458
- Applications: CS 348, 448, 473, 476, 482, 483, 486, 488

The 5.0 non-math units must either be used to satisfy requirements for a minor or a joint honours plan outside the Faculty of Mathematics, or must satisfy the following elective breadth and depth requirements. (*Alternate plans must be approved by a CS advisor.*)

**Elective breadth requirements**

- 1.0 units from the humanities (subjects from ARTS, CHINA, CLAS, CMW, CROAT, DAC, DRAMA, DUTCH, EASIA, ENGL, FINE, FR, GER, GRK, HIST, HUMSC, ITAL, ITALST, JAPAN, JS, KOREA, LAT, MUSIC, PHIL, POLISH, PORT, REES, RS, RUSS, SPAN, SPCOM, UKRAN)
- 1.0 units from the social sciences (subjects from AFM, ANTH, APPLS, BUS, ECON, GEOG, HRM, INTST, INTTS, ISS, LS, MSCI, NATST, PACS, PSCI, PSYCH, REC, SMF, SOC, SOCWK, SPD, STV, WS)
- 0.5 units from the pure sciences (subjects from BIOL, CHEM, EARTH, PHYS, SCI)
- 0.5 units from the pure and applied sciences (subjects from pure sciences plus ARCH, ENVS, ERS, GERON, HLTH, KIN, PLAN)

Note: No course can be used to satisfy more than one of the above requirements.

**Elective depth requirements**

- 1.5 units with the same subject, including at least 0.5 units at third-year level or higher
- or
- 1.5 units with the same subject forming a prerequisite chain of length three

**Bachelor of Mathematics (Computer Science)**

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 27 math courses. Students not taking CS 115 or 135 are required to take an additional third or fourth year CS major course. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

**MATH 237** Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)

MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)

AMATH 242 / CM 271 / CS 371 Introduction to Computational Mathematics or CS 370 Numerical Computation

CM 339 / CS 341 Algorithms

CS 240 Data Structures and Data Management

CS 241 Foundations of Sequential Programs

CS 245 Logic and Computation

CS 246 Software Abstraction and Specification

CS 251 Computer Organization and Design

CS 350 Operating Systems

CS 360 Introduction to the Theory of Computing or CS 365 Models of Computation

One additional CS course chosen from CS 340-398, 440-489.
Two additional CS courses chosen from CS 440-489.

One additional course chosen from

- CO 487/CM 432 Applied Cryptography
- CM 461/STAT 440 Computational Inference
- CS 440-498
- CS 499T Honours Thesis
- CS 600- or 700-level courses

(CS 600- or 700-level courses may be taken only if an equivalent 400-level course does not exist and special permission is obtained from the instructor and a CS undergraduate advisor. Courses in this list may be counted as CS 0.5 units.)

Three additional courses labelled ACTSC, AMATH, CO, CM, PMATH, STAT, excluding the following:

- Courses with requisites normally excluding Honours CS students
- Courses cross-listed with a CS course
- Courses explicitly listed in CS major plans as alternatives to CS courses
- Readings and Topics courses
- ACTSC 221, CO 352, CO 353/CM 441, CO 380, 480

The 5.0 non-math units must satisfy the same restrictions as specified for the Bachelor of Computer Science.

Business Administration and Computer Science Double Degree

Overview

This double degree academic plan is administered jointly by the Faculty of Mathematics at the University of Waterloo (UW) and the School of Business and Economics at Wilfrid Laurier University (WLU). It is a restricted-enrolment plan with admission normally limited to Year One in a fall (September-to-December) term.

Students who successfully complete this plan will be eligible to attend both universities' convocation ceremonies and be awarded a UW Honours BCS degree and a WLU Honours BBA degree at the respective convocations. Students may register for this plan at either university. The academic component is the same, regardless of where students are formally registered, but students participate in the co-op process at their home institution. Thus, the degree attached to each student's registered university is a co-op degree, with the other university's degree being a regular one.

This academic plan cannot be combined with any other major, minor, or option designation except as described in the notes below. It requires a minimum of nine full-time academic study terms and successful completion of a minimum of 52 one-term courses (26 units). These 52 courses (26 units) must include 24 specified courses (12 units) taken at UW and 24 specified courses (12 units) at WLU. The remaining four elective courses (two units) may be taken at either university.

For UW-registered students, the co-op process involves four (or five at a student's discretion) co-op work terms intermixed with study terms. The first of these work terms occurs during the May-to-August period between the second and third study terms. The complete sequencing of terms for UW-registered students is listed in the Study/Work Sequence section. Students in this plan will be required to pay six co-op fees, which are usually assessed in the first three years of study.

For WLU-registered students, the co-op process involves three (or four at a student's discretion) co-op work terms intermixed with the ten study terms. The first of these work terms occurs during the January-to-April period between the third and fourth study terms. The earlier May-to-August period between the second and third study terms is an "off" term (where students are on their own for the term, similar to regular students). With the exception of this first May-to-August term being an "off" term rather than a co-op work term, the term sequencing for WLU-registered students is identical to the one for UW-registered students.

With the sequencing of study terms and work terms indicated above, the normal duration for this plan is four and two-thirds calendar years (or five calendar years at a student's discretion). Only under especially mitigating circumstances, and with the approval of both universities, can the term sequencing attached to the double degree plan be altered, and such instances will usually result in a delay (possibly as much as one calendar year) of graduation date.

All double degree plan students, regardless of their home university affiliation, are required to satisfy all term-by-term progression requirements of both UW's Faculty of Mathematics and WLU's School of Business and Economics to remain eligible to continue in the plan, and to meet all graduation requirements of both institutions to be eligible for the two degrees. More specifically, students must ensure that their course selection each term, their academic performance level, and their academic conduct in general, comply with all the policies, procedures, regulations and requirements of both universities. Failure to do so will normally result in students being required to withdraw from the double degree plan. Such students may remain eligible to enrol in the (single-degree) WLU BBA program (although not necessarily in co-op) or to enrol in another appropriate (single-degree) UW BCS or BMath plan respectively, depending upon their individual circumstances.
Degree Requirements
In addition to satisfying all of the common degree requirements listed in Table I in “Degree Requirements,” students in this double degree plan must successfully complete all of the required courses specified below. Any questions or concerns about any of the overall BCS degree requirements or any of the specified courses should be directed to one of the plan’s academic advisors at UW.

From UW

One of

- CS 115 Introduction to Computer Science 1
- CS 135 Designing Functional Programs

A 300- or 400-level CS major course in addition to those required below

One of

- CS 136 Elementary Algorithm Design and Data Abstraction
- CS 145 Design, Abstraction, and Implementation

All of

- MATH 127 Calculus 1 for the Sciences or MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)
- MATH 128 Calculus 2 for the Sciences or MATH 138 Calculus 2 for Honours Mathematics or MATH 148 Calculus 2 (Advanced Level)
- MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
- MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)
- MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
- STAT 230 Probability or STAT 240 Probability (Advanced Level)
- STAT 231 Statistics or STAT 241 Statistics (Advanced Level)
- CO 250/CM 340 Introduction to Optimization
- CM 339/CS 341 Algorithms
- CS 240 Data Structures and Data Management
- CS 241 Foundations of Sequential Programs
- CS 245 Logic and Computation
- CS 246 Software Abstraction and Specification
- CS 251 Computer Organization and Design
- CS 350 Operating Systems
- CS 490 Information Systems Management
- CS 492 The Social Implications of Computing
- ENGL 210F Genres of Business Communication

Four additional CS courses chosen from CS 340-398, 440-489, with at least two chosen from CS 440-489.

The selection of upper-year CS courses must include at least one course from each of at least two of the following area groups:

- Systems and SE: CS 343, 349, 442, 444, 445, 446, 447, 450, 452, 454, 456, 457, 458
- Applications: CS 348, 448, 473, 476, 492, 493, 486, 488
- Mathematical Foundations of CS: CS 360, 365, 370, 371, 462, 466, 467, 475, 487

From WLU

All of

- BUS 111W Introduction to Business Organization
- BUS 121W Functional Areas of the Organization
- BUS 227W Introduction to Financial Accounting
- BUS 231W Business Law
- BUS 247W Managerial Accounting
- BUS 288W Organizational Behaviour 1
- BUS 352W Introduction to Marketing Management
- BUS 354W Human Resources Management
- BUS 362W Building and Managing Products, Services and Brands
- BUS 383W Financial Management 1
- BUS 385W Operations Management 1
- BUS 393W Financial Management 2
BUS 395W Operations Management 2  
BUS 398W Organizational Behaviour 2  
BUS 481W Business Policy 1  
BUS 491W Business Policy 2  
ECON 120W Introduction to Microeconomics  
ECON 140W Introduction to Macroeconomics

One of

ECON 250W Intermediate Macroeconomic Analysis for Management  
ECON 260W Intermediate Microeconomic Analysis for Management

Five additional 300- or 400- level BUS elective courses (2.5 units) taken in third, fourth or fifth year.

From UW or WLU

Four additional elective courses (2.0 units) are required. Students are free to choose their elective courses from either university.

Notes

1. For details about the various WLU Honours BBA policies, procedures, regulations, and requirements that apply to this double degree plan, please consult the WLU Undergraduate Calendar and/or one of the plan's academic advisors at WLU.
2. Students may, in certain circumstances, be permitted to have one minor or option designation on their UW BCS diploma and transcript. Such a designation must be in a UW discipline outside the areas of study offered by UW's Faculty of Mathematics and outside those offered by WLU’s Department of Business, and it cannot duplicate a similar designation on the student’s WLU academic record. In addition to the approval of the academic unit offering the minor or option, students require the approval of a double degree academic advisor from both UW and WLU to enrol for such a minor or option designation on their UW academic record. Students wishing to have a minor, option, or specialization designation on their WLU academic record should consult the WLU Undergraduate Calendar for details and discuss their situation with an academic advisor from WLU's School of Business and Economics. Electing to have a separate minor, option, or specialization designation is not required for students in the double degree plan, and in some cases, satisfying the combined requirements for both the double degree plan and those for an extra designation may require successful completion of more than 52 courses.

Business Option

The Business Option is available for both the Bachelor of Computer Science and the Bachelor of Mathematics (Computer Science) plans. The requirements are the same as for the BCS and BMath (CS) plans except that;

a) the elective breadth and depth requirements are waived, and
b) both plans include the following additional constraints on course selection:

Two of

CS 348 Introduction to Database Management  
CS 454 Distributed Systems  
CS 490 Information Systems Management

Two of (communications courses)

CS 492 The Social Implications of Computing  
ENGL 109 Introduction to Academic Writing  
ENGL 119 Communications in Mathematics & Computer Science  
ENGL 209 Writing Strategies  
ENGL 210* (various Writing courses)  
SPCOM 100 Interpersonal Communication or SPCOM 223 Public Speaking or SPCOM 225 Interviewing or SPCOM 324 Small Group Communication or SPCOM 325 Organizational Communication

Six of (business courses)

ACTSC 231 Mathematics of Finance  
ACTSC 371 Corporate Finance 1  
AFM 101 Introduction to Financial Accounting or AFM 123/ARBUS 102 Accounting Information for Managers  
AFM 102 Introduction to Managerial Accounting  
AFM 131/ARBUS 101 Introduction to Business in North America or BUS 111W Introduction to Business Organization  
ARBUS 201/ECON 270 The Principles of Entrepreneurship
ARBUS 302/ECON 344 Marketing: Principles of Marketing and Consumer Economics
BUS 121W Functional Areas of the Organization
BUS 362W Building and Managing Products, Services and Brands
BUS 481W Business Policy 1
BUS 491W Business Policy 2
ECON 101 Introduction to Microeconomics
ECON 102 Introduction to Macroeconomics
HRM 200 Basic Human Resources Management
MSCI 211 Organizational Behaviour or PSYCH 338 Organizational Psychology
MSCI 311 Organizational Design and Technology
MSCI 452 Decision Making Under Uncertainty
MTHEL 400 Entrepreneurship, Technology and the Emerging Information Economy
Note: Courses labelled BUS are offered by Wilfrid Laurier’s School of Business and Economics and designated as BU in the WLU calendar. Non-math courses may have enrolment limits or may not easily fit schedules.

Digital Hardware Option (Co-op Only)
Students must apply for entry during 1A and have a cumulative average of 75% or higher. Enrolment in this plan is limited. Graduates of this option do not qualify for the professional engineering designation.

The "Digital Hardware Option" is available for both the Bachelor of Computer Science and the Bachelor of Mathematics (Computer Science). In each case, the requirements are the same except that ECE 222 replaces CS 251, and the following additional constraints apply to course selection:

Two of

CS 452 Real-Time Programming
CS 454 Distributed Systems
CS 456 Computer Networks
CS 457 System Performance Evaluation

All of

ECE 124 Digital Circuits and Systems
ECE 224 Embedded Microprocessor Systems or ECE 325 Microprocessor Systems and Interfacing for Mechatronics Engineering
ECE 327 Digital Hardware Systems
ECE 423 Embedded Computer Systems (first offered in 2014)
ECE 429 Computer Structures or CS 450 Computer Architecture
GENE 123 Electrical Engineering or ME 123 Electrical Engineering for Mechanical Engineers or MTE 120 Circuits
Note: Students taking ECE 429 instead of CS 450 will count this as 0.5 math units in the range CS 440-498, and not 0.5 non-math units.

Recommended course

PHYS 121 Mechanics and Waves 1

Software Engineering Option
The Software Engineering Option is available only for the Bachelor of Computer Science plan. This option is offered jointly by the David R. Cheriton School of Computer Science and the Department of Electrical and Computer Engineering. The rationale for the plan is described in the "Faculty Options" section of the Engineering chapter. Given that the option involves two faculties, it has slightly different realizations in those faculties. Students who complete this option within the Faculty of Mathematics do not qualify for the professional engineering designation. The course requirements are the same as for the Bachelor of Computer Science with the following constraints on upper-year CS courses:

All of

CS 348 Introduction to Database Management

Applications

Foundations
All of

CS 445/ECE 451 Software Requirements Specification and Analysis
CS 446/ECE 452 Software Design and Architectures
CS 447/ECE 453 Software Testing, Quality Assurance and Maintenance
Two of

CS 343 Concurrent and Parallel Programming
CS 349 User Interfaces
CS 444 Compiler Construction
CS 448 Database Systems Implementation
CS 450 Computer Architecture or ECE 429 Computer Structures
CS 452 Real-time Programming
CS 454 Distributed Systems or ECE 454 Distributed and Network Computing
CS 456 Computer Networks or ECE 428 Computer Networks and Security
CS 457 System Performance Evaluation
CS 486 Introduction to Artificial Intelligence or ECE 457 Applied Artificial Intelligence
CS 488 Introduction to Computer Graphics

The following constraints apply to the non-math and free-choice courses:

Societal Issues
One of

ARBUS 202/PHIL 215 Professional and Business Ethics
CS 492 The Social Implications of Computing
GENE 412/PHIL 315 Ethics and the Engineering Profession
GENE 411 Engineering Law and Ethics
ME 401 Law for the Professional Engineer
STV 100 Society, Technology and Values: Introduction
STV 202 Design and Society
STV 302 Information Technology and Society

Note: Choosing CS 492 (a math course) from this list does not reduce the overall requirement to take 5.0 non-math units.

Business Issues
One of

BUS 111W Introduction to Business Organization
BUS 121W Functional Areas of the Organization
HRM 200 Basic Human Resources Management
MSCI 211 Organizational Behaviour
MSCI 311 Organizational Design and Technology
MSCI 454 Technical Entrepreneurship
MTHEL 400 Entrepreneurship, Technology and the Emerging Information Economy

Note: Courses labelled BUS are offered by Wilfrid Laurier’s School of Business and Economics.

Communication
May be replaced with an additional course from the societal or business lists.
One of

ENGL 109 Introduction to Academic Writing
ENGL 119 Communications in Mathematics & Computer Science
ENGL 140R The Use of English 1
ENGL 209 Writing Strategies
ENGL 210E Genres of Technical Communication
ENGL 210F Genres of Business Communication
ENGL 219 Contemporary Usage
ENGL 309E/SPCOM 323 Speech Writing
ENGL 376R Applied English Grammar 1
ENGL 392A Information Design
ENGL 392B Visual Rhetoric
SPCOM 100 Interpersonal Communication
SPCOM 223 Public Speaking
SPCOM 225 Interviewing
SPCOM 324 Small Group Communication

Note: Non-math courses may have enrolment limits or may not easily fit schedules.
Joint Computer Science (Bachelor of Mathematics)
See "BCS and BMath Academic Plan Combinations" for a description of joint plan requirements. Note that both specialization areas designated in such joint plans must be disciplines within the Faculty of Mathematics. The joint requirements for Joint Computer Science (Bachelor of Mathematics) are identical to those for the Joint Bachelor of Computer Science.

Joint Bachelor of Computer Science
The Joint Bachelor of Computer Science and "Z" academic plan, in conjunction with the common degree requirements in Table I in "Degree Requirements," requires a total of 40 courses (20 units), including the courses listed below and the joint honours requirements of "Z." The Math Faculty requirements on overall average and major averages for both plans must be met at the time of declaration of joint honours and must be maintained. It may take more than eight terms to complete a joint honours degree.

One of

CS 115 Introduction to Computer Science 1
CS 135 Designing Functional Programs
A 300- or 400-level CS major course in addition to those required below

One of

CS 136 Elementary Algorithm Design and Data Abstraction
CS 145 Design, Abstraction, and Implementation

All of

MATH 127 Calculus 1 for the Sciences or MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)
MATH 128 Calculus 2 for the Sciences or MATH 138 Calculus 2 for Honours Mathematics or MATH 148 Calculus 2 (Advanced Level)
MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)
MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
STAT 230 Probability or STAT 240 Probability (Advanced Level)
STAT 231 Statistics or STAT 241 Statistics (Advanced Level)
CM 339/CS 341 Algorithms
CS 240 Data Structures and Data Management
CS 241 Foundations of Sequential Programs
CS 245 Logic and Computation
CS 246 Software Abstraction and Specification
CS 251 Computer Organization and Design
CS 350 Operating Systems
One additional course chosen from CS 340-398, 440-489.
Two additional courses chosen from CS 440-489, 499T.
Ten non-math courses satisfying the same restrictions as specified for the Bachelor of Computer Science.

Bioinformatics
This decade has seen an exponential growth in the amount of genetic sequence and protein structure data available to biologists. These data have catalyzed a revolution in how biological and medical science is conducted in both academia and industry. However, due to the sheer volume and complexity of the data, modern computational techniques are required to store, manipulate, visualize, and explore it. Bioinformatics is the interdisciplinary area that applies the latest ideas of computer science to this wealth of new data to solve important biological problems, study the interactions of small molecules with biological receptors, and search for novel therapies for disease. It requires a sophisticated understanding of both the problem domain in biology and the appropriate analytical skills in computer science.

Although Bioinformatics is offered in both co-op and regular, it is intended primarily for co-op students. Regular students will not be able to follow a "traditional" term sequence and will definitely need to study in some spring terms.

In conjunction with common degree requirements in Table I in "Degree Requirements," this plan requires at least 20 units including 1.0 lab units. To continue in any Bioinformatics plan, a student must satisfy the cumulative overall average requirement and cumulative major average requirement for Computer Science of 60%, as specified by the Faculty of Mathematics, and the cumulative major average requirement for Biology of 60%, as specified by the Faculty of Science.

One of

CS 115 Introduction to Computer Science 1
CS 135 Designing Functional Programs
A 300- or 400-level CS major course in addition to those required below
One of

CS 136 Elementary Algorithm Design and Data Abstraction
CS 145 Design, Abstraction, and Implementation

All of

MATH 127 Calculus 1 for the Sciences or MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)
MATH 128 Calculus 2 for the Sciences or MATH 138 Calculus 2 for Honours Mathematics or MATH 148 Calculus 2 (Advanced Level)
MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)
MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
STAT 230 Probability or STAT 240 Probability (Advanced Level)
STAT 231 Statistics or STAT 241 Statistics (Advanced Level)
BIOL 130 Introductory Cell Biology
BIOL 130L Cell Biology Laboratory
BIOL 139 Genetics
BIOL 140 Fundamentals of Microbiology
BIOL 140L Microbiology Laboratory
BIOL 208 Analytical Methods in Molecular Biology
BIOL 250 Organismal and Evolutionary Ecology or BIOL 265 Diversity of Life
BIOL 308 Principles of Molecular Biology
BIOL 365 Resources in Bioinformatics
BIOL 465 Current Topics in Bioinformatics
CHEM 120 Physical and Chemical Properties of Matter
CHEM 120L Chemical Reaction Laboratory 1
CHEM 123 Chemical Reactions, Equilibria and Kinetics
CHEM 123L Chemical Reaction Laboratory 2
CHEM 237 Introductory Biochemistry
CHEM 266 Basic Organic Chemistry 1
CM 339/CS 341 Algorithms
CS 240 Data Structures and Data Management
CS 241 Foundations of Sequential Programs
CS 245 Logic and Computation
CS 246 Software Abstraction and Specification
CS 251 Computer Organization and Design
CS 482 Computational Techniques in Biological Sequence Analysis
CS 483 Computational Techniques in Structural Bioinformatics

Recommended courses

BIOL 331 Advanced Cell Biology
BIOL 342 Molecular Biotechnology 1
BIOL 359 Evolution
CHEM 333 Metabolism 1 (for students interested in Biochemistry)
STAT 333 Applied Probability

Note

A student can qualify for at most one of the following three degrees, regardless of which courses are taken.

Bachelor of Science (Honours Bioinformatics)
This plan requires fulfillment of the core requirements as listed above in Bioinformatics plus the following courses:

All of

BIOL 331 Advanced Cell Biology
BIOL 342 Molecular Biotechnology 1
BIOL 434 Human Molecular Genetics or a fourth-year Biochemistry course
CS 350 Operating Systems

Bachelor of Science (Honours Biology and Bioinformatics)
This plan requires fulfillment of the core requirements as listed above in Bioinformatics plus the following courses:
All of

BIOL 331 Advanced Cell Biology
BIOL 342 Molecular Biotechnology 1
BIOL 434 Human Molecular Genetics
Two additional third- or fourth-year Biology or Biochemistry courses.

Bachelor of Computer Science (Honours Bioinformatics Option)
This plan requires fulfillment of the core requirements as listed above in Bioinformatics plus the following courses:

All of

CS 350 Operating Systems

All of

Two additional courses from CS 340-398, 440-498, and one additional course from CS 440-498.
Note: At least one of these three courses must be from either the Systems and SE list or the Mathematical Foundations list for the Bachelor of Computer Science.

Recommended courses

CS 348 Introduction to Database Management
CS 486 Introduction to Artificial Intelligence

Notes

1. Students in Bioinformatics may not claim a Biology minor with a BCS degree;
2. Students in Bioinformatics may not claim a Computer Science minor with a Bachelor of Science degree.

Computer Science Minor
A "Computer Science Minor" is available to all Honours and four-year General students except in combination with plans that are offered by the School of Computer Science (including shared plans such as Software Engineering, Computing and Financial Management, and any joint plans involving Computer Science).

One of

MATH 103 Introductory Algebra for Arts and Social Science
MATH 106 Applied Linear Algebra 1
MATH 114 Linear Algebra for Science
MATH 115 Linear Algebra for Engineers
MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)

One of

MATH 104 Introductory Calculus for Arts and Social Science
MATH 116 Calculus 1 for Engineering
MATH 117 Calculus 1 for Engineering
MATH 127 Calculus 1 for the Sciences
MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)

A minimum of eight CS courses including:

One of

CS 115 Introduction to Computer Science 1
CS 135 Designing Functional Programs
A 300- or 400-level CS course

One of

CS 116 Introduction to Computer Science 2
CS 136 Elementary Algorithm Design and Data Abstraction
CS 145 Design, Abstraction, and Implementation
One of

CS 230 Introduction to Computers and Computer Systems
CS 241 Foundations of Sequential Programs

One of

CS 234 Data Types and Structures
CS 240 Data Structures and Data Management

Four additional CS courses numbered 200 or higher.

The average of all passed CS courses on the student’s record (including repeated courses) must be at least 60% and at most two CS courses may have failing grades.

Notes

1. Courses listed above must be taken as specified through the Faculty of Mathematics. Exceptions for students who have transferred from other universities will be considered by the Faculty of Mathematics. Such students should submit written requests, including course descriptions, to the Mathematics Undergraduate Office, MC 4022.
2. Some CS courses are not available to students pursuing a CS minor. Consult individual course requisites for details.

Accelerated Master’s Academic Plans in Computer Science

This plan is intended to shorten the usual time required to obtain an MMath. The accelerated plan streamlines the process by allowing a student to complete two graduate courses during their 4A/4B terms that will count towards a MMath degree. This plan will appeal to both BCS and BMath students who already have a good idea of a research project for a master’s degree. The graduate courses they take towards an MMath should be chosen in discussion with their academic advisor and the graduate officer and must be declared extra to their undergraduate degree.

In order to be eligible for this plan an overall average of at least 80% is required. Students are encouraged to apply during their 3B academic term. Applications will also be considered during the 3A term or, in exceptional circumstances, at the start of the 4A term. Application forms are available from the administrative assistant for graduate studies. Students will need to submit a plan for their studies. This plan will include 1) a preferred supervisor, 2) the two graduate courses to be taken in 4A/4B, 3) an outline of proposed research.

Students in this plan will receive financial support of $1,000 per term during their fourth year and will also be guaranteed financial support during their graduate studies should they maintain the required average in the plan. Students are encouraged to apply for scholarships during September of their 4A term. These include both NSERC and the OGS.

Computing and Financial Management

Computing and Financial Management Overview and Degree Requirements

The objective of the Computing and Financial Management program is to provide students with a strong core background in computer science and accounting and financial management. Careful selection of optional courses should permit graduates to go on to graduate studies in these disciplines, with a small number of supplemental courses.

The Computing and Financial Management program is offered jointly by the David R. Cheriton School of Computer Science and the School of Accounting and Finance. Students will be considered to be members of both the Faculty of Arts and the Faculty of Mathematics, although, for administrative purposes, they will be registered in a separate unit. The Honours Computing and Financial Management program leads to a Bachelor of Computing and Financial Management degree.

The course requirements for the Computing and Financial Management program reflect the interdisciplinary nature of this program, with nineteen courses from the Faculty of Mathematics, nineteen courses from the Faculty of Arts, and two general electives, for a total of forty courses.

This program requires successful completion of at least twenty academic course units and all the requirements specified in Table 1, except that the Writing Skills Requirement is as specified by the Faculty of Arts. Work reports must be completed according to Policy 14.2. A student’s standing in the program will be determined according to policies used in the Faculty of Mathematics. The specific course requirements are as indicated below.

The Honours Computing and Financial Management program is also considered an Honours Mathematics plan for purposes of student access to math courses.

One of

CS 135 Designing Functional Programs
A 300- or 400-level CS major course in addition to those required below
All of

- AFM 101 Introduction to Financial Accounting
- AFM 102 Introduction to Managerial Accounting
- AFM 131 / ARBUS 101 Introduction to Business in North America
- AFM 231 Business Law
- AFM 272 / ACTSC 291 Mathematical Managerial Finance 1
- AFM 291 Intermediate Financial Accounting 1
- AFM 372 / ACTSC 391 Mathematical Managerial Finance 2
- AFM 391 Intermediate Financial Accounting 2
- AFM 431 Professional Ethics for Financial Managers
- AFM 472 Investments
- AFM 474 Derivatives and Risk Management
- AFM 475 Fixed Income Securities
- AFM 492 Financial Statement Analysis
- CM 339 / CS 341 Algorithms
- CS 240 Data Structures and Data Management
- CS 241 Foundations of Sequential Programs
- CS 245 Logic and Computation
- CS 246 Software Abstraction and Specification
- CS 251 Computer Organization and Design
- ECON 101 Introduction to Microeconomics
- ECON 102 Introduction to Macroeconomics
- MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
- MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)
- MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)
- MATH 138 Calculus 2 for Honours Mathematics or MATH 148 Calculus 2 (Advanced Level)
- MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
- STAT 230 Probability or STAT 240 Probability (Advanced Level)
- STAT 231 Statistics or STAT 241 Statistics (Advanced Level)
- STAT 373 Regression and Forecasting Methods in Finance

Three of

- AFM 401 Accounting Theory
- AFM 471 Cases in Corporate Finance
- AFM 473 Advanced Topics in Corporate Finance
- AFM 481 Cost Management Systems
- AFM 491 Advanced Financial Accounting
- ARBUS 302 / ECON 344 Marketing: Principles of Marketing and Consumer Economics
- ECON 201 Microeconomic Theory 1
- ECON 202 Macroeconomic Theory 1
- ECON 231 Introduction to International Economics
- SPCOM 223 Public Speaking

One additional course from CS 440–498, CO 487 / CM 432.

Two additional courses from CS 340–398, 440–498, CO 487 / CM 432.

One of

- ENGL 119 Communications in Mathematics & Computer Science
- ENGL 210F Genres of Business Communication

One additional course (0.5 units) from the Faculties of Mathematics or Arts but not in Computer Science or Accounting and Financial Management.

One additional course (0.5 units).

Notes
1. Since the Computing and Financial Management academic curriculum is a combination of the curricula in Computer Science and Accounting and Financial Management, no additional combinations or options will be recognized on a student's transcript or diploma. This does not preclude students from completing additional requirements to enhance their learning.

2. BCFM students have a major average (MAV) based on all math courses and a special average (SMAV) based on all courses taken from the Faculty of Arts. To graduate with a BCFM degree, a student must have a MAV of at least 60% and a SMAV of at least 70%.

3. To continue in the BCFM program a student must normally meet the average requirements specified in the preceding note at the end of each term. The averages, however, are not computed until there are at least three courses available for the average. A student who does not meet the MAV or SMAV requirement at the end of a term, may, at the discretion of a BCFM advisor, be allowed to continue for an additional term in an attempt to raise the average(s) to the required standard.

4. There is very little flexibility for altering the academic/work-term sequence prescribed for the Bachelor of Computing and Financial Management (see the co-op "Study/Work Sequence" section) because of limited term offerings and structured prerequisites for most AFM courses. Since deviations from this sequence can cause a delay in graduation of as much as one calendar year, alterations should not be considered without careful consultation with the appropriate faculty advisor.

Admissions
The BCFM Steering Committee, in consultation with the Faculties of Arts and Mathematics, and their admission committees, determines admission requirements for the BCFM program.

Minimum admission requirements are those of the Faculty of Mathematics, with admissions to the BCFM program handled by the Mathematics Admissions committee, following policies set by the BCFM Steering committee.

English language requirements are those of the Faculty of Arts. Students will be required to have a minimum of 75% in English 4U or equivalent.

Recognition of Excellence

Term Dean's Honours List
The designation "Dean's Honours List" is awarded to any BCFM student who satisfies either of the following criteria:

1. Completed a minimum of 5.0 units which count in the cumulative average, with no NMR’s and a cumulative average of at least 83%.
2. Completed a minimum of 2.5 units in that term with numeric or letter grades, with no excluded courses, no grades of INC, IP, or UR, and a term average of at least 87%.

The Dean's Honours List designation will appear on the student's official University transcript.

Graduation Dean's Honours List
A BCFM student who satisfies either of the following criteria will graduate on the Dean's Honours List.

1. A cumulative overall average of 83% with no INC, IP, NMR, or UR grades
2. A cumulative overall average of 87% with no INC, IP, or UR grades. Any student who satisfies this criterion will have his or her name displayed in gold in the Math Faculty Colloquium Room (MC 5158).

The Dean's Honours List designation will appear on the student's official University transcript and diploma.

Health Informatics Option

Health Informatics Option
The "Health Informatics Option" is a restricted-enrolment plan which is available for honours students in the Faculty of Mathematics. This option requires completion of the following courses:

All of

- HLTH 101 Introduction to Health 1
- HLTH 102 Introduction to Health 2
- HLTH 330 Health Informatics

One of

- HLTH 333 Experimental Methods and Observational Methods in Epidemiology
- HLTH 344 Evaluation, Qualitative, and Survey Methods

One of

- AFM 131/ARBUS 101 Introduction to Business in North America
- BUS 111W Introduction to Business Organization
One of

CS 330 Management Information Systems
CS 490 Information Systems Management

One of

CS 432 Business Systems Analysis
Any course from CS 440-489

Mathematics/Business

Business Administration and Mathematics Double Degree

Overview
This double degree academic plan is administered jointly by the Faculty of Mathematics at the University of Waterloo (UW) and the School of Business and Economics at Wilfrid Laurier University (WLU). It is a restricted-enrolment plan with admission normally limited to Year One in a fall (September-to-December) term.

Students who successfully complete this plan will be eligible to attend both universities' convocation ceremonies and be awarded a UW Honours BMath degree and a WLU Honours BBA degree at the respective convocations. Students may register for this plan at either university. The academic component is the same, regardless of where students are formally registered, but students participate in the co-op process at their home institution. Thus, the degree attached to each student’s registered university is a co-op degree, with the other university’s degree being a regular one.

This academic plan cannot be combined with any other major, minor, or option designation except as described in the notes below. It requires a minimum of nine full-time academic study terms and successful completion of a minimum of 52 one-term courses (26 units). These 52 courses (26 units) must include 24 (12 units) specified mathematics and computer science courses taken at UW and 24 (12 units) specified business-related courses at WLU. The remaining four (two units) elective courses may be taken at either university.

For UW-registered students, the co-op process involves four (or five at a student’s discretion) co-op work terms intermixed with study terms. The first of these work terms occurs during the May-to-August period between the second and third study terms. The complete sequencing of terms for UW-registered students is listed in the Study/Work Sequence section. Students in this plan will be required to pay six co-op fees, which are usually assessed in the first three years of study.

For WLU-registered students, the co-op process involves three (or four at a student’s discretion) co-op work terms intermixed with the ten study terms. The first of these work terms occurs during the January-to-April period between the third and fourth study terms. The earlier May-to-August period between the second and third study terms is an "off" term (where students are on their own for the term, similar to regular students). With the exception of this first May-to-August term being an "off" term rather than a co-op work term, the term sequencing for WLU-registered students is identical to the one for UW-registered students.

With the sequencing of study terms and work terms indicated above, the normal duration for this plan is four and two-thirds calendar years (or five calendar years at a student’s discretion). Only under especially mitigating circumstances, and with the approval of both universities, can the term sequencing attached to the double degree plan be altered, and such instances will usually result in a delay (possibly as much as one calendar year) of graduation date.

All double degree plan students, regardless of their home university affiliation, are required to satisfy all term-by-term progression requirements of both UW’s Faculty of Mathematics and WLU’s School of Business and Economics to remain eligible to continue in the plan, and to meet all graduation requirements of both institutions to be eligible for the two degrees. More specifically, students must ensure that their course selection each term, their academic performance level, and their academic conduct in general, comply with all the policies, procedures, regulations, and requirements of both universities. Failure to do so will normally result in students being required to withdraw from the double degree plan. Such students may remain eligible to enrol in the (single-degree) WLU BBA program (although not necessarily in co-op) or to enrol in another appropriate (single-degree) UW BMath plan respectively, depending upon their individual circumstances.

Degree Requirements
In addition to satisfying all of the Honours BMath degree requirements listed in Table I in "Degree Requirements," students in this double degree plan must successfully complete the Faculty core courses outlined in Table II "Degree Requirements" and all of the required courses specified below. Any questions or concerns about any of the overall BMath degree requirements or any of the specified courses should be directed to one of the plan’s academic advisors at UW.

From UW

All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
ACTSC 231 Mathematics of Finance
CO 250/CM 340 Introduction to Optimization or CO 355 Mathematical Optimization
CO 370/CM 443 Deterministic OR Models
CS 330 Management Information Systems
STAT 371 Statistics for Business 1
STAT 372 Statistics for Business 2

Seven additional 200- or 300- or 400-level math courses.
From WLU
All of

BUS 111W Introduction to Business Organization
BUS 121W Functional Areas of the Organization
BUS 227W Introduction to Financial Accounting
BUS 231W Business Law
BUS 247W Managerial Accounting
BUS 288W Organizational Behaviour 1
BUS 352W Introduction to Marketing Management
BUS 354W Human Resources Management
BUS 362W Building and Managing Products, Services and Brands
BUS 383W Financial Management 1
BUS 385W Operations Management 1
BUS 393W Financial Management 2
BUS 395W Operations Management 2
BUS 396W Organizational Behaviour 2
BUS 481W Business Policy 1
BUS 491W Business Policy 2
ECON 120W Introduction to Microeconomics
ECON 140W Introduction to Macroeconomics

One of

ECON 250W Intermediate Macroeconomic Analysis for Management
ECON 260W Intermediate Microeconomic Analysis for Management

Five additional 300- or 400-level BUS elective courses (2.5 units) taken in third, fourth or fifth year.
From UW or WLU
Four additional elective courses (2.0 units) are required. Students are free to choose their elective courses from either university.

Notes

1. For details about the various WLU Honours BBA policies, procedures, regulations, and requirements that apply to this double degree plan, please consult the WLU Undergraduate Calendar and/or one of the plan’s academic advisors at WLU.
2. The abbreviations “BU” and “EC” are used in the WLU calendar for Business and Economics courses respectively.
3. Students must select one of the three available co-op sequences during their 3A term.
4. UW-registered students who meet all the academic graduation requirements for this plan, but who do not meet the minimum requirements for a co-op degree may, in exceptional circumstances and at the discretion of the Standing and Promotions (S&P) Committee, be awarded a Regular Honours BMath/Business Administration and Mathematics degree.
5. Students in the double degree plan may elect to have one of the following Math Faculty departmental honours majors designated on their UW BMath diploma and transcript: Actuarial Science, Applied Mathematics, Combinatorics and Optimization, Mathematical Finance, Operations Research, Pure Mathematics, or Statistics. To be eligible for such a BMath major designation and the WLU BBA degree, students must satisfy all of the requirements for both the departmental major plan (including the minimum number of total math units) and the double degree plan (as specified above) except as provided for below.
   (a) Students pursuing Actuarial Science are exempt from the following courses: ACTSC 371, ECON 101, 102, ENGL 119, and STAT 331. Additionally, students may take BUS 473W to replace AFM 472.
   (b) Students pursuing Operations Research are exempt from the following courses: AFM 101, 102, 101, 102, MSCI 211, 311, 432, and STAT 331, 332.
   (c) Students pursuing Statistics are exempt from the following courses: STAT 331 and 332.
   (d) Students pursuing Mathematical Finance are exempt from the following courses: ACTSC 371, 372, AFM 101, 102, 131; ECON 101, 102; STAT 331, 443. Also, ECON 260W is an acceptable substitute for ECON 201.
6. Students may, in certain circumstances, be permitted to have a minor and/or option designation on their UW BMath diploma and transcript. Such a designation must be in a UW discipline outside the areas of study offered by WLU’s Department of Business, and it cannot duplicate a
similar designation on the student’s WLU academic record. In addition to the approval of the academic unit offering the minor or option, students require the approval of a double degree academic advisor from both UW and WLU to enrol for such a minor or option designation on their UW academic record. Students wishing to have a minor, option, or specialization designation on their WLU academic record should consult the WLU Undergraduate Calendar for details and discuss their situation with an academic advisor from WLU’s School of Business and Economics. Electing to have a separate major, minor, option, or specialization designation is not required for students in the double degree plan, and in some cases, satisfying the combined requirements for both the double degree plan and those for an extra designation may require successful completion of more than 52 courses.

Information Technology Management

Overview
The effective management of information technology is now a mission-critical component of virtually every enterprise. This plan is designed to equip graduates with the skills necessary to apply modern technology solutions to business processes.

Combining technical courses in computer science, business statistics, optimization and finance with business courses in marketing, project management, electronic business and strategic management of technology, students will be well prepared for exciting careers in business.

Information Technology Management is a restricted-enrolment plan. Students are normally admitted at the Year One level into the Mathematics/Business Administration admission category. In Year Two, provided they remain eligible for an honours program, such students may select the Information Technology Management plan.

Students admitted to the Faculty in other admission categories may subsequently apply for transfer into Information Technology Management at a later date. However, to be admitted, such applicants will normally be required to have a “Good” or “Excellent” academic standing with a minimum 70.0 cumulative overall average (CAV) based on at least 5.0 units of non-excluded courses.

Degree Requirements
In conjunction with the common degree requirements in Table I in “Degree Requirements,” this plan requires 20 math courses. These overall requirements must include the Faculty core courses outlined in Table II in “Degree Requirements” and the following courses:

All of

- MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
- ACTSC 371 Corporate Finance 1
- CO 250/CM 340 Introduction to Optimization or CO 355 Mathematical Optimization
- CS 230 Introduction to Computers and Computer Systems
- CS 330 Management Information Systems
- CS 338 Computer Applications in Business: Databases
- CS 430 Applications Software Engineering
- CS 432 Business Systems Analysis
- CS 436 Distributed Computer Systems
- STAT 371 Statistics for Business 1
- STAT 372 Statistics for Business 2

All of

- AFM 101 Introduction to Financial Accounting
- AFM 102 Introduction to Managerial Accounting
- BUS 111W Introduction to Business Organization
- BUS 121W Functional Areas of the Organization
- BUS 352W Introduction to Marketing Management
- BUS 481W Business Policy 1
- COMM 431 Project Management
- COMM 432 Electronic Business
- ECON 101 Introduction to Microeconomics
- ECON 102 Introduction to Macroeconomics
- MSCI 211 Organizational Behaviour
- MSCI 311 Organizational Design and Technology
- MSCI 421 Strategic Management of Technology
- MTHEL 100 Commercial and Business Law for Mathematics Students
- STV 202 Design and Society
One ENGL or SPCOM course.

Four additional courses (2.0 units).

Notes

1. To graduate with an Honours BMath/Information Technology Management degree, students must achieve a cumulative average of at least 60% based upon all the required non-math courses. Exclusions (if any) from this “Special Major Average” (SMAV) are specified in section 1 under “Faculty Policies.”

2. To remain eligible for Honours BMath/Information Technology Management plan, students must normally have a SMAV (see preceding note 1) of at least 60%.

3. The average requirements in Notes 1 and 2 above are in addition to the cumulative overall average (CAV) and major average (MAV) requirements specified in Table I in “Degree Requirements” and described in detail in sections 1 through 4 under “Faculty Policies.”

4. Students in this plan may elect to pursue a minor or option designation in any discipline except Computer Science.

Mathematical Economics

Overview

Economics and Mathematics are complementary disciplines. Indeed, much of current economic theory is expressed in terms of mathematical models, and most branches of economics use mathematical, statistical and computational concepts extensively. Also, many advances in mathematics have been motivated by problems from economics.

The Faculty of Mathematics and the Faculty of Arts are proud to offer this collaborative plan. In addition to this Mathematical Economics plan offered by the Faculty of Mathematics, the Faculty of Arts also offers a Mathematical Economics plan which leads to a BA degree. Since the junior-level courses are common to both degrees, the structure of the plan makes it easier for students to switch between the two plans. Students contemplating an application to transfer Faculties should consult an advisor regarding important effects of such a change (such applications are not automatically granted).

Degree Requirements

In conjunction with the common degree requirements in Table I in “Degree Requirements,” this plan requires at least 22 math courses. These overall requirements must include the Faculty core courses outlined in Table II in “Degree Requirements” and the courses listed below:

All of

ECON 101 Introduction to Microeconomics
ECON 102 Introduction to Macroeconomics
ECON 201 Microeconomic Theory 1
ECON 202 Macroeconomic Theory 1
ECON 301 Microeconomic Theory 2
ECON 302 Macroeconomic Theory 2
ECON 401 Microeconomic Theory 3
ECON 402 Macroeconomic Theory 3
ECON 421 Econometrics
ECON 472 Senior Honours Essay

Four additional 300- or 400-level ECON courses.

All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
AMATH/PMATH 331 Applied Real Analysis
AMATH 350 Differential Equations for Business and Economics
CO 250 Introduction to Optimization or CO 355 Mathematical Optimization
STAT 331 Applied Linear Models
STAT 443 Forecasting

Seven additional math courses.
Four additional courses (2.0 units).

Notes

1. To graduate with an Honours BMath (Mathematical Economics) degree, students must achieve a cumulative average of at least 75% in all the ECON courses completed. Exclusions (if any) from this “Special Major Average” (SMAV) are specified in Section 1 under “Faculty Policies.”
2. To remain eligible to continue in this plan, students must have a SMAV (see note 1) of at least 75%. This criterion will apply once a student has completed at least three courses towards the average.
3. For graduation and progression purposes, a student's averages will be calculated according to the practices of the Faculty in which the student is formally registered. Should a student transfer from the Mathematics Faculty to the Arts Faculty (or vice versa), the student's average calculations may be revised to reflect the differing average calculation rules.

Mathematics/Business Administration

Overview
The Faculty of Mathematics, in co-operation with various academic units from other faculties at the University of Waterloo (UW) and the School of Business and Economics at Wilfrid Laurier University (WLU), offers the Honours Mathematics/Business Administration plan.

The Mathematics/Business Administration plan provides an opportunity to combine courses in actuarial science, computer science, optimization, and statistics with courses in accounting, business, economics, human resource management, and management sciences. Graduates are well prepared to use sophisticated analytical techniques in the solution of business-related problems and adapt to the rapidly changing modern business environment.

Honours Mathematics/Business Administration is a restricted-enrolment plan. Most of the students enrolled in this plan are admitted at the Year One level directly into the Mathematics/Business Administration admission category.

Students admitted to the Faculty of Mathematics in other admission categories may subsequently apply for transfer to Mathematics/Business Administration at a later date. However, to be admitted, such applicants will normally be required to have a "Good" or "Excellent" academic standing with a minimum 70.0 cumulative overall average (CAV) based on at least 5.0 units of non-excluded courses. Applicants "in good standing" with less than a 70.0 CAV will also be considered on an individual basis if resources available at the time of their application should permit enrolling additional students in the plan.

Required BUS Courses At WLU
In the plan requirements, courses with the prefix BUS are offered by WLU’s School of Business and Economics.

Degree Requirements
In conjunction with the common degree requirements in Table I in "Degree Requirements,” these plans require at least 21 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements” and the courses listed below.

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- ACTSC 371 Corporate Finance 1
- ACTSC 372 Corporate Finance 2
- AMATH 350 Differential Equations for Business and Economics
- CO 250/CMP 340 Introduction to Optimization or CO 355 Mathematical Optimization
- CO 370-CM 443 Deterministic OR Models
- CS 330 Management Information Systems
- CS 338 Computer Applications in Business: Databases
- STAT 371 Statistics for Business 1
- STAT 372 Statistics for Business 2

Two additional math courses.

All of

- AFM 101 Introduction to Financial Accounting or BUS 227W Introduction to Financial Accounting
- AFM 102 Introduction to Managerial Accounting
- BUS 111W Introduction to Business Organization
- BUS 121W Functional Areas of the Organization
- BUS 352W Introduction to Marketing Management
- BUS 481W Business Policy 1
- ECON 101 Introduction to Microeconomics
ECON 102 Introduction to Macroeconomics
HRM 200 Basic Human Resources Management
MSCI 211 Organizational Behaviour or PSYCH 338 Organizational Psychology
MTHEL 100 Commercial and Business Law for Mathematics Students

One of
ENGL 109 Introduction to Academic Writing
ENGL 119 Communications in Mathematics & Computer Science
ENGL 209 Writing Strategies
ENGL 210* (various writing courses)
Any SPCM course

Two additional 300- or 400- level BUS courses.

One additional course (0.5 unit) chosen from
ARBUS 202/PHIL 215 Professional and Business Ethics
MTHEL 400 Entrepreneurship, Technology and the Emerging Information Economy
PACS 202 Conflict Resolution
PACS 323 Negotiation: Theories and Strategies
PSYCH 339 Personnel Selection
Any AFM, BUS, COMM, ECON, HRM, MSCI, PSCI, or STV course

Four additional courses (2.0 units).

Notes

1. To graduate with an Honours BMath/Business Administration degree, students must achieve a cumulative average of at least 60% based upon all 300- and 400- level courses taken with any of the following prefixes: AFM, BUS, COMM, ECON, HRM, MSCI, or MTHEL. Exclusions (if any) from this “Special Major Average” (SMAV) are specified in section 1 under “Faculty Policies.”

2. To remain eligible to continue in the Mathematics/Business plan, students must normally have a SMAV (see preceding Note 1) of at least 60%. This criterion will apply once a student has completed at least three courses towards the average.

3. The average requirements in Notes 1 and 2 above are in addition to the cumulative overall average (CAV) and major average (MAV) requirements specified in Table I in “Degree Requirements” (which includes the degree requirements common to all Math students and described in detail in sections 1 through 4 under “Faculty Policies.”)

Mathematics/Chartered Accountancy (co-op only)

Overview
The Faculty of Mathematics, in co-operation with the School of Accounting and Finance, offers the Honours Mathematics/Chartered Accountancy plans which combine mathematics with accounting and business-related disciplines.

In addition to providing excellent background preparation for careers in industry, these plans can lead to post-graduate studies in business-oriented disciplines. In particular, the Mathematics/Chartered Accountancy plans are specifically designed to be a prelude to UW’s two-term Master of Accounting (MAcc) graduate degree plan in the Faculty of Arts.

Note
In accordance with Math Faculty policy (see “BCS and BMath Academic Plan Combinations”), students in the Honours Mathematics/Chartered Accountancy plans are not eligible for a minor designation nor a joint/double honours designation.

The Honours Mathematics/Chartered Accountancy plans provide an opportunity for studies in Actuarial Science, Computer Science, Optimization, and Statistics combined with an extensive professionally-oriented sequence of accounting courses. Graduates are well prepared to play a leading role in the increasingly important development and utilization of computer-based accounting information systems, the analysis of the information provided by such systems and the subsequent decision-making processes, and allocation of resources so crucial to an organization’s success in the modern business world.

These plans involve four co-op work terms, the first of which occurs in the winter term immediately following the fall 2A academic term (see “Study/Work Sequence”). Students are exempted from paying co-op fees for their 1A and 1B terms.

Admissions
Students normally apply for direct admission from high school into the first year of the Mathematics/Chartered Accountancy plan. Upon successful completion of a provisional first year, students will formally proceed into the Mathematics/Chartered Accountancy plan in second year. Successful completion of the provisional year requires all of the following:

1. Successful completion of at least 5.0 units including the following courses: AFM 101, 102, 131; MATH 135/145, MATH 137/147; one of CS
115, 135, 145; one of MATH 136/146, 138/148; and one of ECON 101, 102. These courses must be completed within 12 months of admission into the provisional year.

- A minimum average of 60% in all math courses taken to date.
- A minimum average of 70% in all AFM and ECON courses taken to date.
- "Good standing" or "Excellent standing" in the Faculty of Mathematics.

Mathematics/Chartered Accountancy is a restricted-enrolment plan, and admission into the plan for students not currently enrolled in the provisional year is not normally granted.

**Degree Requirements**

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 18 math courses and includes all of the following courses:

**One of**

- CS 115 Introduction to Computer Science 1
- CS 135 Designing Functional Programs
- CS 230 Introduction to Computers and Computer Systems
- CS 234 Data Types and Structures
- CS 241 Foundations of Sequential Programs

**All of**

- CS 116 Introduction to Computer Science 2 or CS 136 Elementary Algorithm Design and Data Abstraction or CS 145 Design, Abstraction, and Implementation
- MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
- MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)
- MATH 127 Calculus 1 for the Sciences or MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)
- MATH 128 Calculus 2 for the Sciences or MATH 138 Calculus 2 for Honours Mathematics or MATH 148 Calculus 2 (Advanced Level)
- STAT 230 Probability or STAT 240 Probability (Advanced Level)
- STAT 231 Statistics or STAT 241 Statistics (Advanced Level)
- AFM 272/ACTSC 291 Mathematical Managerial Finance 1
- AFM 372/ACTSC 391 Mathematical Managerial Finance 2
- CS 330 Management Information Systems
- STAT 373 Regression and Forecasting Models in Finance

**All of**

- AFM 101 Introduction to Financial Accounting
- AFM 102 Introduction to Managerial Accounting
- AFM 131/ARBUS 101 Introduction to Business in North America
- AFM 201 Introduction to Professional Practice
- AFM 231 Business Law or MTHEL 100 Commercial and Business Law for Mathematics Students
- AFM 291 Intermediate Financial Accounting 1
- AFM 331 Business Strategy
- AFM 361 Taxation 1
- AFM 391 Intermediate Financial Accounting 2
- AFM 401 Accounting Theory
- AFM 431 Professional Ethics for Financial Managers
- AFM 451 Audit Strategy
- AFM 461 Taxation 2
- AFM 481 Cost Management Systems
- AFM 491 Advanced Financial Accounting
- ECON 101 Introduction to Microeconomics
- ECON 102 Introduction to Macroeconomics
- ENGL 210F Genres of Business Communication
- SPCOM 223 Public Speaking

All of the courses for one of the option choices (a) to (c) below.

**a) Actuarial Science Option**

All of
MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
ACTSC 231 Mathematics of Finance
ACTSC 232 Introduction to Actuarial Mathematics
ACTSC 331 Life Contingencies 1
ACTSC 431 Loss Models 1
STAT 330 Mathematical Statistics
STAT 333 Applied Probability

Four additional courses chosen from any AFM, ECON, MSCI course or any math course (2.0 units).

b) Finance Option

All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
AFM 472 Investments
AFM 476/ACTSC 471 Advanced Corporate Finance
AFM 492 Financial Statement Analysis
AMATH 350 Differential Equations for Business and Economics
STAT 334 Probability Models for Business and Accounting

Two of

ACTSC 445 Asset–Liability Management
ACTSC/STAT 446 Mathematical Models in Finance
CO 250/CM 340 Introduction to Optimization or CO 355 Mathematical Optimization
CO 372 Portfolio Optimization Models
STAT 340 Computer Simulation of Complex Systems

Three additional courses chosen from any AFM, ECON, MSCI course or any math course (1.5 units)

c) Information Systems Management Option

All of

MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
CO 250/CM 340 Introduction to Optimization or CO 355 Mathematical Optimization
CS 338 Computer Applications in Business: Databases
CS 432 Business Systems Analysis

Two of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
CO 351 Network Flow Theory
CO 370/CM 443 Deterministic OR Models
CO 456 Introduction to Game Theory
CS 430 Applications Software Engineering
STAT 340 Computer Simulation of Complex Systems

One of

MSCI 421 Strategic Management of Technology
MSCI 432 Production and Service Operations Management
MSCI 443 Telecommunication Management

Four additional courses chosen from any AFM, ECON, MSCI course or any math course (2.0 units).

Notes

1. To graduate with an Honours BMath/Chartered Accountancy (any option) degree, students must achieve a cumulative average of at least 70% based upon all the required non-math courses that are common to all the options, AFM 272 (cross-listed with ACTSC 291), and AFM 372 (cross-listed with ACTSC 391). Exclusions (if any) from this "Special Major Average" (SMAV) are specified in section 1 under "Faculty Policies."

2. To remain eligible to continue in any Mathematics/Chartered Accountancy plan, students must normally have a SMAV (see preceding Note 1) of at least 70%. This criterion will apply beginning at the end of a student’s 1B term and each term thereafter through to graduation.
3. The average requirements for required non-math courses in Notes 1 and 2 above are in addition to the cumulative overall average (CAV) and major average (MAV) requirements specified in Table I in "Degree Requirements" (which includes the degree requirements common to all Math students) and described in detail in sections 1 through 4 under "Faculty Policies.

4. There is very little flexibility for altering the academic/work-term sequence prescribed for the Mathematics/Chartered Accountancy plans (see "Study/Work Sequence") because of limited term offerings and structured prerequisites for most AFM courses. Since deviations from this sequence can cause a delay in graduation of as much as one calendar year, alterations should not be considered without careful consultation with the appropriate faculty advisor.

5. The order in which required non-math courses in these plans are taken is very important, and there is little room for flexibility (for the same reasons in Note 4 above). During the class enrolment period each term, students should be sure to consult with the appropriate faculty advisor.

6. Students may not repeat an AFM course in which they have obtained a grade of 60% or higher. AFM courses completed with a grade in the range 50 - 59% may be repeated, but only once, and then only with approval from the School of Accounting and Finance.

7. Students who have attempted, to the satisfaction of the Standings and Promotions (S&P) Committee and the Department of Co-operative Education and Career Services, to gain employment for all four available work terms, but are successful in so doing for only three work terms, will be eligible for a co-op degree, provided they have received credit for all three of their work terms and all three of their work reports, and they have successfully completed all academic graduation requirements. (Students who are successful in gaining acceptable employment for four work terms will be required to have credit for all four work terms and all four work reports in order to qualify for a co-op degree.)

8. Students who meet all the academic graduation requirements for this plan, but who do not meet the minimum requirements for a co-op degree (see preceding Note 7) may, in exceptional circumstances and at the discretion of the Standings and Promotions (S&P) Committee, be awarded a Regular Honours BMath/Chartered Accountancy degree with the appropriate option.

Tuition
This is a cost-recovery plan as defined by the Ministry of Education and Training. As such, tuition higher than the normal University of Waterloo tuition is required.

Eligibility for UW’s Master of Accounting (MAcc) Academic Plan
The Math/CA plan is designed to lead to the University of Waterloo Master in Accounting (MAcc) degree. Students should consult the MAcc website to ascertain specific MAcc admission criteria for Math/CA graduates. In addition to other MAcc admission criteria Math/CA graduates are required to have successfully completed MSCI 211 (Organizational Behaviour) as part of their BMath undergraduate studies.

Mathematics/Financial Analysis and Risk Management
Overview
A strong quantitative background is essential for success in the financial analysis and risk management areas. The escalating use of financial derivatives for both hedging and speculation, new governance and banking regulations, and more complex reporting requirements are increasing the demand for professionals with the mathematical background necessary to understand the broad impact these issues can have.

The Faculty of Mathematics is proud to offer this plan, which is designed for students who are interested in working in finance, banking, insurance, or industrial firms in financial analysis or risk management. The two specializations available, Chartered Financial Analyst (CFA) and Professional Risk Management (PRM), provide excellent preparation for the required professional examinations necessary for those designations.

Both the Mathematics/CFA and Mathematics/PRM specialization plans are restricted-enrolment plans. Most of the students enrolled in these plans are admitted at the Year One level directly into the Mathematics/Financial Analysis and Risk Management admission category. In 3A, students must select the specific specialization of their choice from (a) or (b).

Degree Requirements
In conjunction with the common degree requirements in Table I in "Degree Requirements," these plans require at least 22 math courses. These overall requirements must include the Faculty core courses outlined in Table I in "Degree Requirements," and the courses listed below.

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- ACTSC 231 Mathematics of Finance
- ACTSC 371 Corporate Finance 1
- ACTSC 372 Corporate Finance 2
- ACTSC/STAT 446 Mathematical Models in Finance
- AMATH 350 Differential Equations for Business and Economics
- CO 250/CM 340 Introduction to Optimization or CO 355 Mathematical Optimization
CS 330 Management Information Systems
STAT 334 Probability Models for Business and Accounting
STAT 371 Statistics for Business 1
STAT 372 Statistics for Business 2

All of

AFM 101 Introduction to Financial Accounting
AFM 102 Introduction to Managerial Accounting
AFM 472 Investments
BUS 111W Introduction to Business Organization
BUS 121W Functional Areas of the Organization
ECON 101 Introduction to Microeconomics
ECON 102 Introduction to Macroeconomics
MTHEL 100 Commercial and Business Law for Mathematics Students

All of the courses required for one of the specialization choices (a) or (b) below.

a) Chartered Financial Analyst Specialization

All of

AFM 476/ACTSC 471 Advanced Corporate Finance
CO 372 Portfolio Optimization Models

All of

BUS 352W Introduction to Marketing Management
BUS 481W Business Policy 1
COMM 321 Intermediate Accounting for Finance
COMM 421 Financial Statement Analysis
ECON 202 Macroeconomic Theory 1

One of

HRM 200 Basic Human Resources Management
MSCI 211 Organizational Behaviour
PSYCH 338 Organizational Psychology

Four additional courses (2.0 units).

b) Professional Risk Management Specialization

All of

ACTSC 445 Asset-Liability Management
AMATH 242/CM 271/CS 371 Introduction to Computational Mathematics
AMATH/PMATH 331 Applied Real Analysis
CS 338 Computer Applications in Business: Databases

One of

CM 361/STAT 341 Computational Statistics and Data Analysis
CM 375/CS 475 Computational Linear Algebra
CM/CS 476 Numeric Computation for Financial Modeling
STAT 340 Computer Simulation of Complex Systems

One of

CO 370 Deterministic OR Models
CO 372 Portfolio Optimization Models

Two additional non-math courses (1.0 units).

Four additional courses (2.0 units).
Notes

1. To graduate with an Honours BMath/Chartered Financial Analyst Specialization or an Honours BMath/Professional Risk Management Specialization degree, students must achieve a cumulative average of at least 70% based upon all courses taken with any of the following prefixes: AFM, ACTSC, COMM, and ECON. Exclusions (if any) from this “Special Major Average” (SMAV) are specified in section 1 under “Faculty Policies.”

2. To remain eligible to continue in any of the Mathematics/Financial Analysis and Risk Management plans, students must normally have a SMAV (see preceding Note 1) of at least 70%. This criterion will apply once a student has completed at least three courses towards the average.

3. The average requirements in Notes 1 and 2 above are in addition to the cumulative overall average (CAV) and major average (MAV) requirements specified in Table I in “Degree Requirements,” and described in detail in sections 1 through 4 under “Faculty Policies.”

Mathematical Studies

Mathematical Studies Overview
The Mathematical Studies plan is meant for students whose mathematical interests are broadly based. Its high degree of flexibility makes it suitable for those who wish to design a course of study that suits their individual tastes. Under this plan, there is ample scope for students to obtain a minor in an area of mathematics or a minor from another faculty. With judicious course selections, graduates of Mathematical Studies can confidently pursue careers in business, teaching, or public service.

Mathematical Studies
In conjunction with the common degree requirements in Table I in “Degree Requirements,” this plan requires at least 26 math courses, which must include 10 at the 300- or 400-level and the following:

All of

- MATH 106 Applied Linear Algebra 1 or MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)
- MATH 127 Calculus 1 for the Sciences or MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)
- MATH 128 Calculus 2 for the Sciences or MATH 138 Calculus 2 for Honours Mathematics or MATH 148 Calculus 2 (Advanced Level)
- MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
- MATH 225 Applied Linear Algebra 2 or MATH 235 Linear Algebra 2 for Honours Mathematics or MATH 245 Linear Algebra 2 (Advanced Level)
- STAT 220 Probability (Non-Specialist Level) or STAT 230 Probability or STAT 240 Probability (Advanced Level)
- STAT 221 Statistics (Non-Specialist Level) or STAT 231 Statistics or STAT 241 Statistics (Advanced Level)

One of

- CS 115 Introduction to Computer Science 1
- CS 135 Designing Functional Programs
- CS 230 Introduction to Computers and Computer Systems
- CS 234 Data Types and Structures
- CS 241 Foundations of Sequential Programs

One of

- CS 116 Introduction to Computer Science 2
- CS 136 Elementary Algorithm Design and Data Abstraction
- CS 145 Design, Abstraction, and Implementation

One of

- MATH 207 Calculus 3 (Non-Specialist Level) or MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- MATH 229 Introduction to Combinatorics (Non-Specialist Level) or MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)

Notes

1. Students in the Mathematical Studies plan (no specialization), may pursue one minor in a mathematical discipline. Additionally, students may pursue a minor or option designation or joint honours plan with an academic discipline in another faculty. Students may not pursue a
2. Students who complete a minor or joint honours plan in a discipline outside the Faculty of Mathematics are only required to complete 24 math courses.

Mathematical Studies – Business Specialization

In conjunction with the common degree requirements in Table I in “Degree Requirements,” this plan requires at least 24 math courses (see note 2 below), which must include 10 at the 300- or 400-level and the following:

All of

- MATH 106 Applied Linear Algebra 1 or MATH 136 Linear Algebra 1 for Honours Mathematics or MATH 146 Linear Algebra 1 (Advanced Level)
- MATH 127 Calculus 1 for the Sciences or MATH 137 Calculus 1 for Honours Mathematics or MATH 147 Calculus 1 (Advanced Level)
- MATH 128 Calculus 2 for the Sciences or MATH 138 Calculus 2 for Honours Mathematics or MATH 148 Calculus 2 (Advanced Level)
- MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
- MATH 225 Applied Linear Algebra 2 or MATH 235 Linear Algebra 2 for Honours Mathematics or MATH 245 Linear Algebra 2 (Advanced Level)
- STAT 220 Probability (Non-Specialist Level) or STAT 230 Probability or STAT 240 Probability (Advanced Level)
- STAT 221 Statistics (Non-Specialist Level) or STAT 231 Statistics or STAT 241 Statistics (Advanced Level)

One of

- CS 115 Introduction to Computer Science 1
- CS 135 Designing Functional Programs
- CS 230 Introduction to Computers and Computer Systems
- CS 234 Data Types and Structures
- CS 241 Foundations of Sequential Programs

One of

- CS 116 Introduction to Computer Science 2
- CS 136 Elementary Algorithm Design and Data Abstraction
- CS 145 Design, Abstraction, and Implementation

One of

- MATH 207 Calculus 3 (Non-Specialist Level) or MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- MATH 229 Introduction to Combinatorics (Non-Specialist Level) or MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)

Business Specialization

In addition to the course requirements listed above, the Mathematical Studies – Business Specialization plan requires successful completion of the following courses:

All of

- AFM 101 Introduction to Financial Accounting
- AFM 102 Introduction to Managerial Accounting
- AFM 131/ARBUS 101 Introduction to Business in North America or BUS 111W Introduction to Business Organization
- ARBUS 302/ECON 344 Marketing: Principles of Marketing and Consumer Economics or BUS 352W Introduction to Marketing Management
- BUS 121W Functional Areas of the Organization
- ECON 101 Introduction to Microeconomics
- ECON 102 Introduction to Macroeconomics

Three additional courses chosen from

- MTHEL 100 Commercial and Business Law for Mathematics Students
MTHEL 400 Entrepreneurship, Technology and the Emerging Information Economy
PACS 202 Conflict Resolution
PACS 323 Negotiation: Theories and Strategies
Any AFM, BUS, COMM, ECON, HRM, MSCI, STV course

In addition to the business-related courses above, this specialization requires that the following be included in the math courses chosen as part of the Mathematical Studies plan.

All of

CO 227 Introduction to Optimization (Non-Specialist Level) or CO 250/CM 340 Introduction to Optimization or CO 355 Mathematical Optimization
CO 327 Deterministic OR Models (Non-Specialist Level) or CO 370/CM 443 Deterministic OR Models
CS 330 Management Information Systems

One of

AFM 272/ACTSC 291 Mathematical Managerial Finance 1
ACTSC 221 Mathematics of Investment
ACTSC 231 Mathematics of Finance
ACTSC 371 Corporate Finance 1

Two of

CS 200 Concepts for Advanced Computer Usage*
CS 338 Computer Applications in Business: Databases
CS 430 Applications Software Engineering
CS 432 Business Systems Analysis
STAT 340 Computer Simulation of Complex Systems
* students wishing to take CS 200 must do so prior to taking any other 200-level or higher CS courses

One of

STAT 321 Regression and Forecasting (Non-Specialist Level)
STAT 331 Applied Linear Models
STAT 371 Statistics for Business 1
STAT 373 Regression and Forecasting Methods in Finance

Notes

1. Students in the Mathematical Studies plan (no specialization), may pursue one minor in a mathematical discipline. Additionally, students may pursue a minor or option designation or joint honours plan with an academic discipline in another faculty. Students may not pursue a joint or double honours plan from within the Faculty of Mathematics.
2. Students who complete the Business specialization, or either a minor or joint honours plan in a discipline outside the Faculty of Mathematics, are only required to complete 24 math courses.

Mathematics/Teaching Option

Mathematics/Teaching Option Overview
The co-operative Mathematics Teaching Option is an integrated plan offered jointly by the Faculty of Mathematics at the University of Waterloo and the Faculty of Education at Queen's University. This plan combines academic studies in mathematics, teaching experience in secondary schools, and professional training, with the graduate fully qualified as a secondary school mathematics teacher in Ontario.

Students interested in this restricted-enrolment plan should enrol in the Honours Mathematics co-operative plan in Year One, and will be considered for admission to the Teaching Option in Year Two on the basis of two interviews and satisfactory academic and work-term performance.

Work-term arrangements in this option differ from other co-operative plans offered in the Faculty. (Consult the "Study-Work Sequence" section.) Details concerning this and the Faculty of Education component are available from the academic advisors or the co-ordinator for this option.

Mathematics/Teaching Option (co-op only)
In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 24 math courses. The math courses submitted for the degree must include at least eight 300- or 400-level math courses, and students are encouraged to gain as much
Mathematical breadth as possible. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
- ACTSC 221 Mathematics of Investment
- CO 250/CM 340 Introduction to Optimization
- CS 234 Data Types and Structures

One of

- AMATH 250 Introduction to Differential Equations
- AMATH 343 Discrete Models in Applied Mathematics

One of

- AMATH/PMATH 331 Applied Real Analysis
- AMATH/PMATH 332 Applied Complex Analysis

One of

- CO 380 Mathematical Discovery and Invention
- CO 480 History of Mathematics

One of

- CS 230 Introduction to Computers and Computer Systems
- CS 330 Management Information Systems
- CS 338 Computer Applications in Business: Databases
- CS 370 Numerical Computation
- CS 430 Applications Software Engineering
- CS 436 Distributed Computer Systems

One of

- PMATH 334 Introduction to Rings and Fields with Applications
- PMATH 336 Introduction to Group Theory with Applications

One of

- PMATH 330 Introduction to Mathematical Logic
- PMATH 340 Elementary Number Theory
- PMATH 360 Geometry

One of

- STAT 331 Applied Linear Models
- STAT 332 Sampling and Experimental Design
- STAT 333 Applied Probability

All of

- MTHEL 206A Introduction to Mathematics Education

Recommended non-math courses include

- PSYCH 212/212R Educational Psychology
- PHIL 311 Philosophy of Education 1
- PHIL 312 Philosophy of Education 2

Notes
1. Successful completion of the academic requirements for any of the departmental honours plans "X" in the Faculty of Mathematics, whether leading to a BCS or a BMath degree, will be accepted as a replacement for the math course requirements listed above provided that "X" is not a Mathematical Studies plan. All requirements specified in Table I must be completed, however, even if the departmental honours plan provides exemptions from any of those requirements. Students who elect this option will be designated by a plan label such as "Honours X/Teaching Option" rather than "Honours Mathematics/Teaching Option." (Since 3B and 4B courses are not normally offered in the spring term, it will be difficult to satisfy this alternative.)

2. The Bachelor of Education requirements are completed during an eight-month education study unit in the Faculty of Education at Queen's University in Kingston. This unit occurs in the fall and winter terms following completion of 3B.

3. The selection of courses required for the BMath Teaching Option must include a second teaching subject in one of the following disciplines: biology, chemistry, computer science, or physics. Eight courses (four units) are required to qualify for a second teaching subject.

Pure Mathematics

Pure Mathematics Overview

Mathematics is both an art and a science, and Pure Mathematics lies at its heart. Many study Pure Mathematics to pursue knowledge for its own sake and because of its beauty. Others want a strong foundation for graduate work or have a desire to apply their knowledge. Pure Mathematics courses explore the boundary of Mathematics and pure reason; they stimulate the mind, promise intellectual growth, and are an asset to any plan. We hope to impart to our students a love for learning, and to develop their abilities to work independently, and to think critically and creatively. This is achieved with small classes and a supportive atmosphere in which all students are challenged to fulfill their academic potential.

Pure Mathematics graduates have been successful in a wide variety of careers. Many go into industry, as the skills they have acquired are recognized by employers as being valuable and transferable. Others go into education at all various levels or continue their studies at graduate school in either Mathematics or some other discipline.

Pure Mathematics comprises a broad spectrum of Mathematics. Interests of the Department include algebra, number theory, analysis, geometry, topology, logic and functional equations, and range from the very classical to the most modern. The Department offers several honours plans including Honours Pure Mathematics, Honours Pure Mathematics with Electrical Engineering Electives, Honours Pure Mathematics/Teaching Option and Honours Mathematical Finance. It is also possible to do a minor in Pure Mathematics. All, except the Teaching Option and Pure Mathematics with Electrical Engineering Electives (which are co-op plans only), are available to both co-op and regular students. Co-operative students should be in stream four by the beginning of their 3B term.

Many students have found it rewarding to combine Pure Mathematics with another mathematical discipline. For such students double and joint honours plans are available. Students from other departments, especially those considering pursuing graduate work (in any area of Mathematics), are encouraged to speak with a Pure Mathematics advisor about which Pure Mathematics courses would be particularly important, interesting, and beneficial for them.

Students who have enjoyed their core mathematics courses and would like to obtain a broad base in mathematics, at a less intensive level than the traditional Honours Pure Mathematics plans, may be interested in pursuing an Honours Mathematical Sciences plan with an emphasis in Pure Mathematics. These plans are individually tailored, and may be combined with a minor in another faculty and/or with an emphasis in another department in the Mathematics Faculty. Interested students should consult a Pure Mathematics advisor.

A more detailed description of the Department and its plans may be found in the Pure Mathematics Undergraduate Handbook, on the Web at www.math.uwaterloo.ca/PM_Dpt/.

Pure Mathematics

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 26 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
AMATH 333/PMATH 365 Elementary Differential Geometry
PMATH 345 Polynomials, Rings and Finite Fields
PMATH 346 Group Theory
PMATH 351 Real Analysis
PMATH 352 Complex Analysis
PMATH 354 Measure Theory and Fourier Analysis

Three 400-level PMATH courses.

Two additional 400-level math courses.

Joint Pure Mathematics

See "BCS and BMath Academic Plan Combinations" for a description of joint plan requirements. Note that both specialization areas designated in such joint plans must be disciplines within the Faculty of Mathematics.
All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
AMATH/PMATH 331 Applied Real Analysis or PMATH 351 Real Analysis
AMATH/PMATH 332 Applied Complex Analysis or PMATH 352 Complex Analysis
PMATH 334 Introduction to Rings and Fields with Applications or PMATH 345 Polynomials, Rings and Finite Fields
PMATH 336 Introduction to Group Theory with Applications or PMATH 346 Group Theory

Three additional PMATH courses.

One of

MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
An additional PMATH course

Pure Mathematics with Electrical Engineering Electives (co-op only)

Enrolment in this plan is limited. Students must have a cumulative average of 75% or higher.

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires 24 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
CS 234 Data Types and Structures
CS 370 Numerical Computation
PMATH 345 Polynomials, Rings and Finite Fields
PMATH 346 Group Theory
PMATH 352 Complex Analysis
PMATH 354 Measure Theory and Fourier Analysis
PMATH 351 Real Analysis

One pair of

AMATH 231 Calculus 4
AMATH 250 Introduction to Differential Equations
or
MATH 211/ECE 205 Advanced Calculus 1 For Electrical and Computer Engineers
MATH 212/ECE 206 Advanced Calculus 2 For Electrical Engineers or AMATH 231 Calculus 4

All of

ECE 241 Circuit Analysis and Design
ECE 342 Signals and Systems
GENE 123 Electrical Engineering
PHYS 121 Mechanics and Waves 1
PHYS 122 Mechanics and Waves 2

Two of

ECE 318 Analog and Digital Communications
ECE 370 Electromagnetic Fields
ECE 380 Analog Control Systems

Two 400-level ECE courses to be chosen in consultation with an advisor (usually a student would be advised to take two courses in sequence).

Three 400-level PMATH courses.

Pure Mathematics/Teaching Option (co-op only)

Students must be accepted into the Teaching Option to be eligible for this plan.

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 24 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:
All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
AMATH 231 Calculus 4
AMATH 242/CM 271/CS 371 Introduction to Computational Mathematics
AMATH 250 Introduction to Differential Equations
AMATH/PMATH 331 Applied Real Analysis or PMATH 331 Real Analysis
PMATH 334 Introduction to Rings and Fields with Applications or PMATH 345 Polynomials, Rings and Finite Fields
PMATH 360 Geometry

Two of

AMATH/PMATH 332 Applied Complex Analysis or PMATH 352 Complex Analysis
PMATH 330 Introduction to Mathematical Logic
PMATH 336 Introduction to Group Theory with Applications or PMATH 346 Group Theory
PMATH 340 Elementary Number Theory

One additional PMATH course.

One of

CO 380 Mathematical Discovery and Invention
CO 480 History of Mathematics

Three additional 300- or 400-level math courses.

All of

MTHEL 206A Introduction to Mathematics Education

Notes

1. The Bachelor of Education requirements are completed during an eight-month education study unit in the Faculty of Education at Queen's University in Kingston. This unit occurs in the fall and winter terms following completion of 3B.
2. The selection of courses required for the BMath Teaching Option must include a second teaching subject in one of the following disciplines: biology, chemistry, computer science, or physics. Four units are required to qualify for a second teaching subject.
3. Candidates are required to have a half-year university course in Developmental Psychology (or equivalent), or a full-year university course in Introductory Psychology before receiving the Bachelor of Education.

Mathematical Finance

The Mathematical Finance plan is offered jointly by the Departments of Statistics and Actuarial Science and of Pure Mathematics.

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 26 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

MATH 247 Calculus 3 (Advanced Level) or MATH 237 Calculus 3 for Honours Mathematics*
AFM 101 Introduction to Financial Accounting
AFM 102 Introduction to Managerial Accounting
AFM 131/ARBUS 101 Introduction to Business in North America
ACTSC 231 Mathematics of Finance
ACTSC 371 Corporate Finance 1
ACTSC 372 Corporate Finance 2
ACTSC 445 Asset-Liability Management
ACTSC/STAT 446 Mathematical Models in Finance
AMATH 242/CM 271/CS 371 Introduction to Computational Mathematics
AMATH 250 Introduction to Differential Equations
AMATH 431/PMATH 451 Measure and Integration
ECON 101 Introduction to Microeconomics
ECON 102 Introduction to Macroeconomics
ECON 201 Microeconomic Theory 1
PMATH 351 Real Analysis
PMATH 354 Measure Theory and Fourier Analysis
STAT 330 Mathematical Statistics
STAT 331 Applied Linear Models
STAT 333 Applied Probability
STAT 443 Forecasting
* MATH 237 requires permission of department

One of
AMATH 351 Ordinary Differential Equations 2
CM 340 Introduction to Optimization
CM 352 Computational Optimization
PMATH 352 Complex Analysis

One of
AMATH 353 Partial Differential Equations 1
AMATH 432/PMATH 453 Functional Analysis
CM 372 Portfolio Optimization Models
CM/CS 476 Numeric Computation for Financial Modeling

Note
MATH 147 and 148 provide highly desirable background for students in the Mathematical Finance plan.

Pure Mathematics Minor
This minor is only open to students within the Faculty of Mathematics. Students in other faculties should be aware that there is another Pure Mathematics minor available to them.

Six PMATH courses. MATH 237 or MATH 247 may be substituted for one of the six.

Software Engineering
Software Engineering
Over the last few decades there has been a tremendous growth in information technology and its impact on everyday life. Complex software systems have become critical to the operation of many systems in areas such as banking, communications, manufacturing, power generation, and transportation. Progress in computer science and accumulated experience with industrial production of software have led to the emergence of software engineering as a separate discipline. The software engineering discipline has been defined as "the application of systematic, disciplined, quantifiable approaches to the development, operation, and maintenance of software"; that is, the application of engineering to software. The software engineer must apply well-defined techniques, methods, and tools to ensure the correctness, reliability, performance, maintainability, and usability of the software systems being developed.

The technical requirements of these software engineers include a strong foundation in mathematics, natural sciences, and computer science; a broad education in software engineering and design; an understanding of computers and networks; a better appreciation for all aspects of the software engineering life cycle; and the use of methodologies and tools.

The curriculum requirements are not all technical. Industry is also asking for graduates who have facility across several disciplines. Software engineering graduates need to have substantial communications, business, and reasoning skills. Graduates should be able to work in groups; make presentations to technical and non-technical audiences; write coherent well-reasoned reports; and assess the social, technical, legal, and commercial implications of the technology they help to create.

The Honours Software Engineering program leads to a Bachelor of Software Engineering degree. The program is accredited by both the Canadian Engineering Accreditation Board and the Computer Science Accreditation Council.

Administrative Structure
Leadership for the Software Engineering program is provided by a Software Engineering Program Director, normally a faculty member chosen from either Computer Science or Electrical and Computer Engineering with a joint or cross appointment. The Program Director is responsible for the academic issues associated with the program's operations, including student liaison and advisement. The Associate Director of Software Engineering assists the Director in managing the program's day-to-day operations and in advising students.

The Software Engineering Program Board oversees the program's operation and evolution. This inter-faculty Board consults with the two home departments and reports to the two Faculty Councils. The Chair of the Board alternates between the Dean of the Faculty of Engineering and the Dean of Mathematics. Ex-officio members of the board include the

● Dean of Engineering
Dean of Mathematics
Director of the David R. Cheriton School of Computer Science
Chair of Electrical and Computer Engineering
Director (or Associate Director) of Undergraduate Studies (CS)
Associate Chair of Undergraduate Studies (ECE)
Software Engineering Program Director

In addition, the board includes four faculty members, two from Computer Science and two from Electrical and Computer Engineering; and one student from the Software Engineering program. Faculty members are appointed for two-year, renewable terms; the student member typically serves a two-term appointment. The Software Engineering Curriculum Committee is responsible for the maintenance and evolution of the program curriculum and is chaired by the Software Engineering Program Director. The committee consists of six faculty members (three from Computer Science and three from Electrical and Computer Engineering, including the appropriate Electrical and Computer Engineering Theme Area Chair and the Computer Science Director of Undergraduate Studies) and one student from the Software Engineering Program. The membership may be drawn from outside of the Board. The Software Engineering Curriculum Committee reports to the Software Engineering Program Board and consults with both the Computer Science Curriculum Committee and the Electrical and Computer Engineering Program Committee.

Admissions
The Software Engineering Program Board, in consultation with the Faculties of Engineering and Mathematics and their Admissions Committees, determines the admission requirements for the Software Engineering program.

For details on admission information, see Specific Admission Requirements and Recommendations for Year One Programs in the Admissions section of this calendar.

English Language Proficiency Requirement
Students in the Software Engineering program must satisfy this requirement as set down by the Faculty of Engineering (see Engineering’s English Language Proficiency Requirement).

MINORS, OPTIONS, AND JOINT HONOURS

Although Software Engineering students are considered to be both Math and Engineering students, and can thus take advantage of most academic opportunities available to students from either Faculty, BSE students have only three options directly supported by their program: the Option in Management Sciences (from Engineering), the Business Option (from Computer Science), and the Cognitive Science Option (a university-wide option). This does not preclude students from completing the requirements for other eligible degree enhancements, such as other Options, Minors, or Joint programs; but these must be arranged by the students and completed in addition to the normal BSE degree requirements. Students must consult the Software Engineering Associate Director for eligible degree enhancements.

Students should be aware that an option will constrain the choice of elective courses and may require additional courses. Thus, it is advisable to start planning for options in the first and second years. Students should also consider the benefits of not pursuing an option, in that they are better able to personalize their curriculum if they have more flexibility in choosing their electives.

Option in Management Sciences
This option consists of six courses (see "Option in Management Sciences" under Designated Options in the Faculty of Engineering section) designed for those students who are interested in the management of technology.

Note that the required course MSCI 331 and the elective course MSCI 431 are not open to Math Faculty students, which means that they are not open to Software Engineering students. Students enrolled in the option must take CD 250 in lieu of MSCI 331. CS 457 can substitute for MSCI 431.

The successful completion of these courses results in a designation on the transcript "Option in Management Sciences."

Business Option
This option consists of ten courses (see "Business Option" under Computer Science in the Faculty of Math section) designed for those students who are interested in business and marketing.

The successful completion of these courses results in a designation on the transcript "Business Option."

Cognitive Science Option
This option consists of eight courses (see Cognitive Science Option under Cognitive Science in the Faculty of Arts section) designed for those students who are interested in the nature of thinking and intelligence.

The successful completion of these courses results in a designation on the transcript "Cognitive Science Option."

SOFTWARE ENGINEERING AWARDS

Term Dean's Honours List
In recognition of outstanding academic achievement in an academic term, the designation "Dean's Honours List" is awarded to any BSE student who satisfies either of the following criteria:

1.1. The student is unconditionally promoted at the end of that term, and his or her term average minus his or her percentile rank from the top for that academic term is at least 80.
1.2. The student completes the academic term with a term average of at least 87% based upon a course load which includes a minimum of 2.5 units
with numeric or letter grades and which does not include any failing grades or any INC, IP, or UR grades.

This designation will be reflected on the official university transcript.

**Graduation "With Distinction - Dean's Honours List"**

In recognition of outstanding academic achievement throughout undergraduate studies, the designation Graduation "With Distinction - Dean's Honours List" is awarded to any BSE graduate who satisfies either of the following criteria:

1.1. The student has satisfied criterion "1" of the term Dean's Honours List for at least two of the six academic terms preceding graduation, and has a cumulative average over these last six academic terms of at least 80.

1.2. The student has a cumulative average (as specified in Mathematics Faculty Policy #1) of at least 87% with no record of INC, IP, or UR grades. Any student who satisfies this criterion will have his or her name displayed in gold in the Math Faculty Colloquium Room (MC 5158).

This designation will appear on the student's official University transcript and diploma.

Some of the upper-year awards offered by the Faculties of Engineering and Mathematics are open to Software Engineering students. If such an Engineering or Mathematics award specifies that the recipient achieve term "Dean's Honours List" or "Graduating 'With Distinction - Dean's Honours List,'" then a Software Engineering student must satisfy the appropriate Faculty's Dean's Honours List criteria in order to be eligible for the award.

**Honours Software Engineering (Co-operative 8-stream only)**

The Software Engineering program is offered jointly by the David R. Cheriton School of Computer Science and the Department of Electrical and Computer Engineering.

Its curriculum prepares graduates for entry into the software engineering profession. It covers the scientific and mathematical foundations of the discipline, engineering science and engineering design appropriate to the discipline, and exposes students to the ethical and societal issues associated with the discipline. Graduates will be able to apply their knowledge to produce software solutions to specific problems.

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

**ACADEMIC CURRICULUM**

### 1A Fall

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tr>
<td>CS 137 Programming Principles</td>
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<td>ECE 105 Physics of Electrical Engineering 1</td>
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<tr>
<td>ECE 140 Linear Circuits</td>
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<td>1</td>
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<tr>
<td>MATH 115 Linear Algebra for Engineering</td>
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<td>2</td>
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<tr>
<td>MATH 117 Calculus 1 for Engineering</td>
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<tr>
<td>SE 101 Introduction to Methods of Software Engineering**</td>
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### 1B Winter

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<th>Course</th>
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<tr>
<td>SE 102 Seminar</td>
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<td>CS 138 Functional Programming and Data Abstraction</td>
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<td>ECE 106 Physics of Electrical Engineering 2</td>
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<td>ECE 124 Digital Circuits and Systems</td>
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<tr>
<td>MATH 119 Calculus 2 for Engineering</td>
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<tr>
<td>MATH 135 Algebra for Honours Mathematics</td>
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### 2A Fall

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<td>SE 201 Seminar</td>
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<tr>
<td>CHE 102 Chemistry for Engineers</td>
<td>3</td>
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<tr>
<td>CS 241 Foundations of Sequential Programs</td>
<td>3</td>
<td>1</td>
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<tr>
<td>ECE 222 Digital Computers</td>
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<tr>
<td>SE 212 Logic and Computation</td>
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<td>STAT 206 Statistics for Software Engineering</td>
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<td>WKRPT 100 Work-term Report</td>
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<tr>
<td>SE 202 Seminar</td>
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<tr>
<td>CS 240 Data Structures and Data Management</td>
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<td>CS 246</td>
<td>Software Abstraction and Specification</td>
<td>3</td>
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<td>MSCI 251</td>
<td>Engineering Economics: Financial Management for Engineers</td>
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<tr>
<td>MATH 213</td>
<td>Advanced Mathematics for Software Engineers</td>
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<td>MATH 239</td>
<td>Introduction to Combinatorics</td>
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<td>WKRPT 200</td>
<td>Work-term Report</td>
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<tr>
<td>TPM 000</td>
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<td>3A Winter</td>
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<tr>
<td>SE 301</td>
<td>Seminar</td>
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<tr>
<td>CS 341</td>
<td>Algorithms</td>
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<td>SE 350</td>
<td>Operating Systems</td>
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<td>SE 380</td>
<td>Introduction to Feedback Control</td>
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<td>SE 382</td>
<td>Human-computer Interaction</td>
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<td>SE 302</td>
<td>Seminar</td>
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<tr>
<td>CS 343</td>
<td>Concurrent and Parallel Programming</td>
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<tr>
<td>CS 348</td>
<td>Introduction to Database Management</td>
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<tr>
<td>SE 390</td>
<td>Design Project Planning</td>
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<td>SE 463</td>
<td>Software Requirements Specification and Analysis</td>
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<td>WKRPT 300</td>
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<tr>
<td>SE 401</td>
<td>Seminar</td>
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<td>SE 464</td>
<td>Software Design and Architectures ***</td>
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<tr>
<td>SE 490</td>
<td>Design Project 1 ***</td>
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<td>ECE 428</td>
<td>Computer Networks and Security</td>
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<td>WKRPT 400</td>
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<td>4B Winter</td>
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<tr>
<td>SE 402</td>
<td>Seminar</td>
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<tr>
<td>SE 465</td>
<td>Software Testing and Quality Assurance ***</td>
<td>3</td>
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<tr>
<td>SE 491</td>
<td>Design Project 2 ***</td>
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<tr>
<td>Four Electives (see note 1)</td>
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</tbody>
</table>

* Alternate weeks
** One hour seminar per week
*** Lab is not scheduled and students are expected to find time in open hours to complete their work

Four Advanced Technical Electives (ATE):
Advanced technical electives expose students to advanced software technologies, domain-specific designs, and large applications, on which they can practice their software-engineering skills. The advanced technical electives comprise primarily third- and fourth-year course offerings in CS or ECE.

One of the following CS courses (CS List):

- CS 360 Introduction to the Theory of Computing
- CS 370 Numerical Computation
- CS 442 Principles of Programming Languages
- CS 444 Compiler Construction
- CS 448 Database Systems Implementation
- CS 450 Computer Architecture
- CS 452 Real-time Programming
- CS 454 Distributed Systems
- CS 457 System Performance Evaluation
- CS 458 Computer Security and Privacy
- CS 462 Formal Languages and Parsing
- CS 466 Algorithm Design and Analysis
CS 473 Medical Image Processing
CS 475 Computational Linear Algebra
CS 486 Introduction to Artificial Intelligence
CS 487 Introduction to Symbolic Computation
CS 488 Introduction to Computer Graphics
SE 498 Advanced Topics in Software Engineering

One of the following ECE courses (ECE list):

- ECE 318 Analog and Digital Communications
- ECE 324 Microprocessor Systems and Interfacing
- ECE 327 Digital Hardware Systems
- ECE 411 Digital Communications
- ECE 412 Coded Digital Communications
- ECE 413 Digital Signal Processing
- ECE 414 Wireless Communications
- ECE 418 Communications Networks
- ECE 429 Computer Architecture
- ECE 454 Distributed and Network Computing
- ECE 457 Applied Artificial Intelligence
- ECE 464 Digital Control Applications
- ECE 486 Robot Dynamics and Control
- ECE 488 Multivariable Control Systems

One additional 400-level course from the CS and ECE lists

One of

- An additional 400-level course from the CS and ECE lists
- CO 487 Applied Cryptography
- SYDE 433 Conflict Resolution
- SYDE 558 Fuzzy Logic and Neural Networks
- SYDE 475 Image Processing
- SE 499 Project

Two Science Electives (SCE)

Normally these courses are in the natural sciences, chosen from the list below. Alternate courses may be chosen in consultation with the SE Program Advisors.

Science Elective Courses:
- BIOL 130 (including 130L), 139, 140, 273, CHE 161, CHEM 262 (including 262L), EARTH 121 (including 121L), PHYS 122, 234, 246, 275, 334, 375

Four Linkage Electives (LE)

At least one from each of the areas of Societal Issues, Humanities and Social Sciences, and Communications, as specified below. Students should be aware that these courses may have enrolment limits, or may not fit their schedules.

One course on Societal Issues:
- CS 492, Complementary Studies Elective List A

One course on Communication:
- ENGL 109, 119, 140R, 210F, 219, SPCOM 100, 223, 324, 432

Two additional courses on Humanities and Social Sciences:
- Complementary Studies Elective List C

Notes

1. There are eleven electives. As detailed above, these electives must include four advanced technical electives, two science electives, and four linkage electives. For their remaining elective, students may choose to take any of an additional advanced technical elective, an additional science elective, any course from the complementary studies electives lists, a foreign-language linguistics or grammar course, BUS 111W, BUS 121W, MTHEL 400, or any other course approved by the SE Program Advisor. Advanced Technical Electives may not be taken before the 3A term; 400-level Advanced Technical Electives may not be taken before the 3B term.
2. Students enrolled in Software Engineering will only be permitted to use the WD and WF provisions used in the Faculty of Mathematics to withdraw from extra courses taken above and beyond the degree requirements.
3. Foreign-language courses must be approved by the SE advisor.
4. With the consent of the SE Program Advisor, students having an advanced background in programming may take CS 145 instead of CS 137/CS 138. These students must take one additional course selected with the consent of the SE Program Advisor.

Four Work-term Reports (WKRPT)

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

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

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

Technical Presentation Milestone (TPM)

Each student registered in Software Engineering is required to satisfy the Technical Presentation Milestone (TPM) during his or her 2B term. If admitted to the Software Engineering program after 2B, then the student must satisfy this requirement before the end of the student’s first academic term in the program. The topic of the presentation is expected to be some aspect of the work-term report that the student submits in his or her 2B term. The details of the TPM requirement are provided during the student’s 2A term, so that the student can plan appropriately for the presentation during the work-term preceding 2B. A student who is interested in formal instruction on how to develop and deliver an oral presentation should consider taking SPCOM 223.

Statistics

Statistics Overview

Statistics deals with the collection and analysis of data. Statistical methods are extensively used in biology, medicine, health sciences, agriculture, business, finance, economics, engineering, and many other fields. Claims based on statistical arguments appear daily in the press, and it is difficult to assess these claims intelligently without knowledge of statistical methods.

The statistician’s first job is to determine what data to collect, and how to collect it so that it will be without bias or distortion. These problems are discussed in the Design of Experiments and Sample Surveys. Statistical Inference is concerned with inferring what the population is like on the basis of a small amount of data (the sample). The link between population and sample is provided by Probability Theory, which forms an important part of the statistics curriculum. Developing and assessing statistical models to describe the variation in some response in terms of other explanatory variables, and applications of these models is discussed throughout the statistics curriculum.

Other areas of pure and applied mathematics find applications in statistics. Calculus and linear algebra are used in the undergraduate program; abstract algebra, combinatorics, difference and differential equations, analysis, and measure theory are required in more advanced work. Many statistical analyses involve the computer, so a good background in computing is highly desirable.

Statistics

In conjunction with the common degree requirements in Table I in “Degree Requirements,” this plan requires at least 26 math courses. These overall requirements must include the Faculty core courses outlined in Table II in “Degree Requirements” and the following courses:

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- STAT 330 Mathematical Statistics
- STAT 331 Applied Linear Models
- STAT 332 Sampling and Experimental Design
- STAT 333 Applied Probability

One of

- MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
- AMATH 231 Calculus 4
- AMATH 242/CM 271/CS 371 Introduction to Computational Mathematics
- AMATH 250 Introduction to Differential Equations

Two 400-level STAT courses.

One additional 300- or 400-level STAT course.

One of
CS 457 System Performance Evaluation
CS 483 Computational Techniques in Structural Bioinformatics
CS 486 Introduction to Artificial Intelligence
CS 488 Introduction to Computer Graphics

One additional 400-level STAT course

Note: CS 457, 486, and CS 488 are open only to those with a major in CS.

Four additional 300- or 400-level math courses.

Joint Statistics

See "BCS and BMath Academic Plan Combinations" for a description of joint plan requirements. Note that both specialization areas designated in such joint plans must be disciplines within the Faculty of Mathematics.

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- STAT 330 Mathematical Statistics
- STAT 331 Applied Linear Models
- STAT 333 Applied Probability

Two 400-level STAT courses.

One additional 300- or 400-level STAT course.

Statistics for Health (co-op only)

Statistics for Health is a restricted-enrolment plan. Admission to the plan is by application to the Department of Statistics and Actuarial Science. Co-op students must have a cumulative average of at least 60% to be admitted to the plan. Students who are not in co-op are not eligible for the Statistics for Health plan.

In conjunction with the common degree requirements in Table I in "Degree Requirements," this plan requires at least 24 math courses. These overall requirements must include the Faculty core courses outlined in Table II in "Degree Requirements" and the following courses:

All of

- MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
- STAT 232 Introduction to Medical Statistics
- STAT 330 Mathematical Statistics
- STAT 331 Applied Linear Models
- STAT 332 Sampling and Experimental Design
- STAT 333 Applied Probability
- STAT 431 Generalized Linear Models and their Applications
- STAT 436 Introduction to the Analysis of Spatial Data in Health Research
- STAT 437 Analysis of Longitudinal Data in Health Research

One of

- MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)
- AMATH 231 Calculus 4
- AMATH 242/CM 271/CS 371 Introduction to Computational Mathematics
- AMATH 250 Introduction to Differential Equations

Two additional 300- or 400-level math courses.

All of

- AFM 101 Introduction to Financial Accounting
- AFM 102 Introduction to Managerial Accounting
- CS 330 Management Information Systems
- CS 338 Computer Applications to Business: Databases
- CS 432 Business Systems Analysis
- ECON 101 Introduction to Microeconomics
- ECON 201 Microeconomic Theory 1
- ECON 301 Microeconomic Theory 2
Statistics Minor
This minor is only open to students within the Faculty of Mathematics.

All of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)

Three of

STAT 330 Mathematical Statistics
STAT 331 Applied Linear Models
STAT 332 Sampling and Experimental Design
STAT 333 Applied Probability

Two additional 300- or 400-level STAT courses.

Plans for Students outside the Mathematics Faculty

Joint Honours Academic Plans with Mathematics
The requirements listed below apply for all students admitted to the Mathematics portion of such joint honours plans for the fall 2004 term or thereafter.

(a) Course requirements for admission
To be eligible for admission to a Joint Honours "Z" with Mathematics academic plan, a student must first be accepted for admission to an honours academic plan by a relevant discipline "Z" in another faculty. To be eligible to combine that honours plan "With Mathematics" to form a joint honours plan, a student must also normally have successfully completed all of the six math courses listed immediately below and not already have exceeded the failure maximum limit allowed for a joint honours academic plan [see section (c) below]. A minimum grade of 70 is normally required for any of the CS 11X or 12X courses or MATH 106, 12X, or 225, a minimum grade of 50 in CS 145, MATH 14X, or 245 and a minimum grade of 60 for any other courses listed here.

One of

MATH 106 Applied Linear Algebra 1
MATH 136 Algebra for Honours Mathematics
MATH 146 Algebra for Honours Mathematics (Advanced Level)

One of

MATH 127 Calculus 1 for the Sciences
MATH 137 Calculus 1 for Honours Mathematics
MATH 147 Calculus 1 for Honours Mathematics (Advanced Level)

One of

MATH 128 Calculus 2 for the Sciences
MATH 138 Calculus 2 for Honours Mathematics
MATH 148 Calculus 2 for Honours Mathematics (Advanced Level)

One of

MATH 225 Applied Linear Algebra 2
MATH 235 Linear Algebra 2 for Honours Mathematics
MATH 245 Linear Algebra 2 for Honours Mathematics (Advanced Level)

One of
One of

CS 116 Introduction to Computer Science 2
CS 136 Elementary Algorithm Design and Data Abstraction
CS 145 Design, Abstraction, and Implementation

(b) Additional course requirements

All of

MATH 135 Algebra for Honours Mathematics or MATH 145 Algebra (Advanced Level)
STAT 230 Probability or STAT 240 Probability (Advanced Level)
STAT 231 Statistics or STAT 241 Statistics (Advanced Level)

One of

MATH 237 Calculus 3 for Honours Mathematics or MATH 247 Calculus 3 (Advanced Level)
MATH 239 Introduction to Combinatorics or MATH 249 Introduction to Combinatorics (Advanced Level)

Four additional math courses that qualify for Honours BMath degree credit.

(c) Maximum Failure Requirement

The maximum number of failures allowed for a Joint Honours "Z" With Mathematics academic plan is 3.00 units. Included in this failure count are all failures that appear on a student's University of Waterloo official transcript, regardless of whether or not such failures are being included as part of the student's record for his/her degree by the relevant faculty for discipline "Z."

(d) Course Substitutions

Exceptions for students wishing to substitute other UW courses (e.g., math courses offered under Engineering Faculty course labels such as ECE or SYDE), or courses taken at another university, in place of the courses in section (a) above will be considered on an individual basis.

(e) Graduation Average Requirement

To graduate in a Joint Honours "Z" With Mathematics plan, a student requires a minimum average of 60 based upon all the UW math courses that a student has passed which a student enrolled in the Faculty of Mathematics could have taken for BMath degree credit. This average will include all such courses including repeated courses, regardless of whether or not such courses are being included as part of the student's record for his/her degree by the relevant faculty for discipline "Z."

Computer Science Minor

CS minor requirements.

Mathematics Minor

A "Mathematics Minor" is available for honours or four-year general students in other faculties. This minor requires a total of ten math courses which must include the following specific courses:

All of

MATH 106 Applied Linear Algebra 1 or MATH 114 Linear Algebra for Science or MATH 115 Linear Algebra for Engineering
MATH 116 Calculus 1 for Engineering or MATH 117 Calculus 1 for Engineering or MATH 127 Calculus 1 for the Sciences
MATH 118 Calculus 2 for Engineering or MATH 119 Calculus 2 for Engineering or MATH 128 Calculus 2 for the Sciences

Two of

STAT 220 Probability (Non-Specialist Level)
STAT 221 Statistics (Non-Specialist Level)
STAT 321 Regression and Forecasting (Non-Specialist Level)
STAT 322 Sampling and Experimental Design (Non-Specialist Level)

One of
One of

CS 116 Introduction to Computer Science 2
CS 126 Introduction to Software Development
CS 136 Elementary Algorithm Design and Data Abstraction
CS 145 Design, Abstraction, and Implementation

Three additional math courses which qualify for BMath degree credit.

For the complete set of courses on the student’s record that could be used to satisfy any of the course requirements above (a) the average of all passed courses (including repeated courses) must be at least 60% and (b) at most two courses may have failing grades.

Notes

1. The Mathematics minor designation is not available to students pursuing a joint honours with Mathematics.
2. A student who obtains a Mathematics minor may not also obtain another minor offered by the Faculty of Mathematics.
3. The MATH courses listed above may be replaced by the equivalent courses for honours mathematics students. For example, instead of MATH 116 or 117 or 127, a student may take MATH 137 or 147.
4. Courses listed above must be taken as specified through the Faculty of Mathematics. Exceptions for students who have transferred from other universities will be considered by the Faculty of Mathematics. Such students should put their requests in writing, provide course descriptions, and submit this documentation to the Mathematics Undergraduate Office, MC 4022.

Pure Mathematics Minor

A “Pure Mathematics Minor” is available for honours and four-year general students in other faculties. This minor requires a total of ten math courses which must include the following specific courses:

All of

MATH 106 Applied Linear Algebra 1 or MATH 114 Linear Algebra for Science or MATH 115 Linear Algebra for Engineering
MATH 116 Calculus 1 for Engineering or MATH 117 Calculus 1 for Engineering or MATH 127 Calculus 1 for the Sciences
MATH 118 Calculus 2 for Engineering or MATH 119 Calculus 2 for Engineering or MATH 128 Calculus 2 for the Sciences

Four PMATH courses, chosen in consultation with a Pure Mathematics advisor.

Three additional math courses which qualify for BMath degree credit.

For the complete set of courses on the student’s record that could be used to satisfy any of the course requirements above (a) the average of all passed courses (including repeated courses) must be at least 60% and (b) at most two courses may have failing grades.

Notes

1. The Pure Mathematics minor designation is not available to students pursuing a joint honours with Mathematics.
2. A student who obtains a Pure Mathematics minor may not also obtain another minor offered by the Faculty of Mathematics.
3. The MATH courses listed above may be replaced by the equivalent courses for honours mathematics students. For example, instead of MATH 116 or 117 or 127, a student may take MATH 137 or 147.
4. Courses listed above must be taken as specified through the Faculty of Mathematics. Exceptions for students who have transferred from other universities will be considered by the Faculty of Mathematics. Such students should put their requests in writing, provide course descriptions, and submit this documentation to the Mathematics Undergraduate Office, MC 4022.

Faculty Policies

Degree requirements and policies that apply to students enrolled in the BSE degree program are included in the Software Engineering program description.

1. Averages for Math Students

All averages calculated for degree students enrolled in the Faculty of Mathematics include all relevant course grades, except for:

http://ugradcalendar.uwaterloo.ca/printing/?groupID=117
(a) courses explicitly excluded, either because they have failing grades or by request of the student, within the limits specified in Table I in "Degree Requirements";
(b) courses taken while the student was enrolled in another UW faculty or at another post-secondary institution; and
(c) any other courses that are ineligible for credit toward the student’s degree (e.g., courses that may not be counted for degree credit by any Math student) or for credit in the student’s particular academic plan (e.g., CS non-major courses for students enrolled in a CS major plan).

A passed course may be repeated at most once and both marks will be included in averages, unless excluded according to one of (a), (b), or (c) above.

The Faculty of Mathematics computes several averages. In all cases, courses excluded earlier in this section are not included in averages.

Cumulative average (CAV): The average of all courses taken by the student while enrolled in the Faculty of Mathematics.

Term average (TAV): The average of all courses taken by the student in a particular term. A TAV is computed for each term in which a student is enrolled in the Faculty of Mathematics.

Faculty average (FAV): The average of all math courses taken by the student while enrolled in the Faculty of Mathematics.

Major average (MAV): The definition of this average varies according to the student’s major (see section 2).

Special major average (SMAV): Not all students in the Faculty will have a SMAV. Details on its definition, and when it applies, are in section 2.

A student’s CAV and most recent TAV, along with failure count, are the primary factors in determining that student’s “standing” in the Faculty (see section 3). The FAV does not formally contribute toward determining a student’s standing, but is informally used by the Standings and Promotions Committee when a student petitions for an exception to Faculty policies.

2. Major Averages for Honours Students

Subject to the exclusion/inclusion provisions (stipulated in section 1, above) which apply to all average calculations in the Faculty, "major" averages (commonly identified as "MAV") for honours students are based upon all the student’s 300/400-level math courses (including any course cross-listed with a 300- or 400-level math course), except for the specific plans listed below:

- For Computer Science major plans, the major average ("MAV") is based upon CS 134, 136, 145, all the student’s subsequent CS major courses, as well as CS courses numbered 600 and higher, and courses CO 487/CM 432, CM 461/STAT 440, ECE 222, 427, and 429, SE 112, 240, 382, 463, 464, and 465.
- For Actuarial Science major plans, the major average ("MAV") is based upon ACTSC 231, 232, STAT 230/240, 231/241, and all the student’s 300/400 level math courses.
- For Mathematics/Business Administration, Mathematics/Chartered Accountancy, and Mathematics/Financial Risk Management plans, in addition to having a major average ("MAV") based upon all the student’s 300/400-level math courses, also have a second ("special") major average ("SMAV") as described in Notes 1 and 2 of the plan requirement sections.
- ForHonours Bioinformatics plans, in addition to having a first Computer Science major average ("MAV") as described above, also have a second ("special") Biology-related major average ("SMAV") which is based upon all the student’s BIOL courses.
- The BCFM plan has a major average ("MAV") based on all math courses and a second ("special") major average ("SMAV") based on all courses from the Faculty of Arts.
- For all plans combining two major areas of study within the Faculty of Mathematics, each area of study has its own separate major ("MAV") average calculated as described above. In such situations, the major-average graduation requirements in Table I in "Degree Requirements" and the major-average continuation requirements described in section 4 (to follow) apply to both major averages respectively.

3. Academic Standing within the Faculty

This section specifies the basic rules that determine a student’s academic standing. Students should consult sections 4, 5, and 6.4 below for additional rules that may affect their standing.

3.1 To remain in the Faculty of Mathematics, a student may not have more than 3.0 units of excluded courses. A student who exceeds this limit will be required to withdraw. Note that, in addition to passed courses excluded at the student’s request, failed courses will be excluded automatically. Any student required to withdraw may be eligible to graduate with a general degree under the Honours Fallback Provision, if they meet the requirements for a general degree when they are required to withdraw.

3.2 A student’s standing is assessed after each term of registration. Subject to 3.1,
- if CAV >= 80%, a student is "In Excellent Standing";
- if CAV < 80% and CAV >= 60%, a student is "In Good Standing";
- if CAV <60%, a student is "On Academic Probation."

If, however, the preceding criteria indicate "Good" or "Excellent" standing (or indicate no standing because a student has no courses with grades that can be used to compute a CAV) but a student has excluded units exceeding one-half the passed and non-excluded units (not including external
3.3 After a full-time term, or the equivalent, on academic probation, students must be in good standing, or have TAV > 65%, to continue in their plan. Otherwise, withdrawal from the Faculty of Mathematics is required. Any student required to withdraw may be eligible to graduate with a general degree under the Honours Fallback Provision, if they meet the requirements for a general degree when they are required to withdraw.

3.4 Following the term in which a student reaches 2.0 excluded units, regardless of the academic standing for the term, the student will be blocked from enrolling in classes until the student has spoken to an advisor concerning his/her academic situation.

3.5 A student may be required to withdraw from the Faculty of Mathematics if, in the opinion of the Standings and Promotions (S&P) Committee, the student is unlikely to profit from further study in the Faculty or is not making satisfactory progress toward fulfilling degree requirements. In particular, any full-time student who does not pass at least two courses in his/her 1A term will be required to withdraw from the Mathematics Faculty, unless the one course passed is a math course with a mark of at least 60%, in which case the student may be allowed to continue at the discretion of the Standings and Promotions (S&P) Committee.

3.6 A "Required to withdraw - may not continue in Faculty" academic standing normally means that a student is no longer eligible for any subsequent degree studies in the Faculty of Mathematics. However, a student may submit a petition to the Standings and Promotions (S&P) Committee to enroll for one final term of non-degree studies, provided that term will follow an absence of at least two terms. Such petitions are likely to be granted only if the student is requesting a non-degree term of courses selected to enhance the chances for admission to a program of study outside the Faculty, either at the University of Waterloo or at some other post-secondary institution.

3.7 Students whose first enrolment in the Faculty of Mathematics was September 2004 or later may take full advantage of the revised rules for academic standing described above. Students whose first enrolment in the Faculty of Mathematics was prior to September 2004 may take advantage of the increased limits on excluded (previously, failed) units, by counting both failed and excluded courses against the new limit, but only courses taken in the fall 2004 term or later may be excluded. That is, grades for failed courses taken prior to fall 2004 will be included in averages, unless one of the exclusion provisions in the 2005/2006 Undergraduate Calendar applies.

4. Major Average Continuation Requirement for Honours Academic Plans

The major average will only take effect once it includes at least two course grades for Computer Science major plans, and once it includes at least three course grades for all other honours plans.

Honours students in Applied Mathematics, and Pure Mathematics major plans, as well as those enrolled in Mathematical Finance and Mathematical Physics, must normally have a cumulative major average (as defined in section 2 earlier) of at least 65% to remain eligible to continue in their plan. Students with a cumulative major average less than 65%, but at least 60%, may be allowed, at the discretion of their departments, to continue on a conditional basis in their plan in an attempt to raise their cumulative major average to 65%. Students who fail to do so after one full-time academic term (or the equivalent) will normally be required to withdraw from their major plan.

Honours students in Actuarial Science must have a cumulative major average (as defined in section 2 earlier) of at least 70% to remain eligible to continue in their plan. Honours students in other plans must normally have a cumulative major average (as defined in section 2 earlier) of at least 60% to remain eligible to continue in their plan. Students with a cumulative major average less than 60%, but at least 55%, may be allowed, at the discretion of their major Department(s) or the Dean’s Office, as appropriate, to continue on a conditional basis in their plan in an attempt to raise their cumulative major average to 60%. Students who fail to do so after one full-time academic term (or the equivalent) will normally be required to withdraw from their plan. Students who are unable to satisfy the major average admission or continuation standard of any honours plan will normally be required to withdraw from the Math Faculty.

For all joint and double honours plans within the Faculty, the major average requirements of both majors must be satisfied.

5. Conditions for Remaining in Co-op

5.1 Students who are eligible to continue in their academic plan may remain in co-op, provided that they are making satisfactory progress towards meeting the Faculty’s minimum requirements for work terms and work reports.

5.2 Students with a cumulative average (i.e., overall GPA) less than 60%, or for whom the total of their excluded course units exceeds one half the total of their passed (and not excluded) course units, will normally be suspended from the CECS employment process during their next academic term.

In most instances (with the exception of students with a previously arranged two-work-term commitment), in order to administratively implement the suspension, students will have their system of study changed from co-op to regular, effective their first full-time academic term following the term that led to their suspension. Then, as regular students, they will not be required to pay co-op fees during the time they are suspended from co-op. Students who have been suspended from co-op will be permitted, and sometimes encouraged, to enrol in consecutive full-time academic terms.

If students have already secured employment for a co-op work term immediately following the academic term that led to their suspension, they will be expected to honour that employment commitment, and that work term will be eligible for official co-op work-term credit in the event that they are subsequently reinstated to co-op. In addition, students with a two-work-term commitment already in place will normally be expected to return to work for that same employer following their next scheduled academic term (during which they will normally remain enrolled in co-op and pay co-op fees). In other instances, however, employment secured for a term immediately following suspension from the CECS job-search employment process will not normally be recognized for official co-op work-term credit.
5.3 After one full-time academic term (or equivalent) in a regular plan, suspended students will be eligible to apply for reinstatement to co-op. Provided that they are otherwise eligible for co-op, reinstatement will be automatic for applicants who have attained "Good" or "Excellent" academic standing. In all cases, applications for reinstatement must be submitted no later than the end of the first complete week of the academic term for which reinstatement is requested. However, if after one full-time academic term (or equivalent) on suspension, students have not attained "Good" or "Excellent" standing, they will normally not be eligible for any further enrolment in co-op. Exceptions may be made in some instances for students who are judged to have made significant academic improvement, but have not yet attained "Good" or "Excellent" standing.

5.4 Normally, students who warrant suspension from the CECS employment process more than once will be permanently removed from co-op.

5.5 Students in co-op plans for which no corresponding regular plan exists will be dealt with following the principles in 5.4 to 5.6 as closely as possible, given the lack of a corresponding regular plan. Since removal from co-op is potentially more significant for such students, their individual circumstances will be considered in making decisions.

5.6 If a co-op student accumulates a combined total of four grades of NCR for PD courses and work reports, the student will be required to withdraw from the co-op system of study.

6. Course Drop Policy
This section applies to dropping individual courses, with one or more other courses remaining in the student's registration. For complete withdrawal from a term, see 10, below.

6.1 A student may drop courses without academic penalty during the "Drop, No Penalty" period.

6.2 A student may withdraw from one or more courses per term, subject to restrictions imposed by the Faculty, during the "Drop, Penalty 1" period. These courses will remain on a student's record and will be assigned grades of WD. Each WD grade will count as a course attempt but will not be included in the student's averages, units completed, or failure counts.

6.3 A student may withdraw from one or more courses during the "Drop, Penalty 2" period. A student should consult an academic advisor before withdrawing during this interval, because these courses will remain on a student’s record with a grade of WF (withdrawal/ failure) and will count as failures.

6.4 A first-year student who has never previously been registered for a term of full-time study at a degree-granting post-secondary institution may withdraw from some or all of his/her core math courses after the tenth week of lectures until the last day of lectures and obtain a cleared grade of WD in each. Such withdrawals must be requested through the Mathematics Faculty; students should consult with a first-year advisor.

6.5 The Faculty's degree requirements stipulate that the difference between the number of units attempted and the number of units completed cannot exceed five. Thus, a student will be required to withdraw if the total unit value of excluded courses, WDs, and repetitions of (non-excluded) passed courses exceeds five units. Any student required to withdraw may be eligible to graduate with a general degree under the Honours Fallback Provision, if they meet the requirements for a general degree when they are required to withdraw.

7. Examinations
7.1 The Faculty of Mathematics constitutes the examining body for all examinations for courses in the Faculty and, through the Standings and Promotions (S&O) Committee, approves all decisions concerning grades and academic standing.

7.2 The Faculty of Mathematics does not grant Supplementary Examinations for students who fail courses, except for certain situations involving students in Engineering or Software Engineering.

Further details concerning University examination requirements may be found in the following PDF document "University of Waterloo Examination Regulations and Related Matters."

8. Grades
8.1 Numerical grades in the range 0-100 are assigned in all courses in the Faculty of Mathematics except the Computer Science Honours Thesis, CS 499T. The minimum passing mark in all courses is 50.

8.2 If a student does not write a final examination and does not give a properly documented reason (e.g., illness), the instructor will either submit a grade of DNW (did not write) or submit a numerical grade based on the term work, with a grade of zero for the exam.

8.3 In exceptional circumstances, for example an examination missed due to illness (see 12.2 to follow), an instructor may assign a grade of INC (course incomplete). A grade of INC will not be assigned simply because a student is concerned that he/she will otherwise fail the course. A grade of INC which is not cleared by the deadline set by the instructor, which will normally be no later than eight months after the end of term, will be automatically converted to an FTC (failure to complete, no credit granted). Students should not register again in a course for which they have an outstanding INC grade and cannot use the course for prerequisite purposes for subsequent courses.

8.4 An AEG grade gives credit for a course, but no numerical mark for averaging purposes. This grade is rarely used, and only when a student has done outstanding work during the term but is unable to write the final exam due to documented illness of a serious nature.

8.5 The grade Under Review (UR) may be imposed by the Associate Dean, Undergraduate Studies, while an alleged offence is under investigation or appeal. Once the discipline case is resolved, the UR grade will be replaced with the final grade. A student with an outstanding INC, IP, NMR, and/or UR on his/her record will be unable to graduate until the INC, IP, NMR, and/or UR has been replaced by a grade and the grade has been factored into the averages.
8.6 Grades are not official until the "fully graded" date when academic standings are released by the Registrar's Office. However, once the official examination period is over, unofficial grades will be available to students through Quest. Grades will appear on Quest as soon as they are entered by the Registrar's Office. Faculty policy does not permit instructors to release grades during the examination period.

8.7 Students in the Faculty of Mathematics may not register for official Audit (AUD) status in a course. This policy applies to all undergraduate students in Mathematics, including non-degree students and students on exchange programs from other universities. This policy does not apply to post-degree students, who are permitted to register for official AUD status.

9. Grade Appeals
A student may find that the grade received for a course is significantly lower than anticipated following the final exam. In this situation, the student may informally ask the instructor to check the calculation of the final grade. If questions concerning a grade cannot be resolved informally, a student may request to have the final exam re-marked by submitting a "Math Faculty Grade Appeal" form to the Mathematics Undergraduate Office. These forms may be obtained from the Mathematics Undergraduate Office. As part of this process, the student may ask to see a copy of his/her final exam.

It should be noted that failing grades are automatically reviewed by the instructor, and in a multi-section course the examinations are marked in common by all instructors so that students in all sections are treated on a common basis. Students should be aware that a grade may decrease as a result of a request for a re-mark.

If, following a grade appeal, a student has serious concerns about how his/her grade was assigned, the student should discuss the matter with the Associate Dean for Undergraduate Studies. In such a situation, University Policy 70 permits a student to request a formal reassessment.

10. Voluntary Withdrawal from a Term/Inactive Status
A student may withdraw from all courses up to the last official day of lectures for the term, by submitting a completed "Undergraduate Notice of Withdrawal" form to the Registrar's Office. Such a student is considered to have "Voluntarily Withdrawn" from that term. If the form is submitted no later than the last day of the third week of lectures, which is typically also the end of the period for 100% tuition-fee refund, the term will not be recorded on the student's academic record. With the exception noted in the following paragraph, if a student withdraws after the end of the third week of lectures, all courses in which the student is currently enrolled will remain on his/her academic record, with WD or WF grades. The grade is assigned according to the date of withdrawal, using the same rules as for dropping individual courses (see 6.2 and 6.3 above).

A first-year student who has never been previously registered at a degree-granting post-secondary institution will normally be permitted to withdraw from all of his/her courses without academic penalty as late as the last official day of lectures for his/her first term. These courses, however, will continue to appear on their academic record with a grade of WD. Such students may resume their studies after an absence of two terms (eight months). Students wishing to pursue this option must inform the Registrar's Office.

A Mathematics student who has completed at least one term of study and who has been inactive (i.e., not been registered as a candidate for a degree offered through the Faculty of Mathematics, or on an approved Letter of Permission) for more than four consecutive academic terms must apply for re-admission by writing to the Assistant Registrar, Faculty of Mathematics. A resume covering the inactive period, including official transcripts from any post-secondary institutions attended in the interim, must be included. If the student is re-admitted, Faculty policies in effect at the time of re-admission will apply, unless stated otherwise by the Faculty when re-admission is approved.

11. Petitions and the Standings and Promotions (S&P) Committee
On occasion, due to illness or other circumstances beyond a student’s control, it may be appropriate for a student to make a petition requesting that an exception be made to a Faculty or University regulation. All such petitions are considered by the Standings and Promotions (S&P) Committee, which consists of a representative from each department and each area of study, and is chaired by the Associate Dean for Undergraduate Studies. Petitions should be made on a "Petition for Exception to Academic Regulations (Form 70A)" form obtainable from the Mathematics Undergraduate Office, and should be submitted to the Registrar’s Office together with supporting documents (e.g., a medical certificate). It is often useful to discuss the situation with an academic advisor before submitting a petition.

12. Illness

12.1 Illness During the Term
If a student becomes seriously ill during the term, it may be desirable for his/her course load to be reduced or for the student to withdraw completely from the academic term. If this occurs after the official course drop deadline, the student should submit a petition to the Standings and Promotions (S&P) Committee, supported by a medical certificate, requesting permission to drop one or more courses. It is essential for the student to assess the situation and take the appropriate action immediately. Petitions of this nature must be made before the end of the lecture period.

12.2 Illness During the Exam Period
- If a student becomes ill during the exam period and as a result misses an exam, he/she must provide a medical certificate to his/her instructor as soon as possible, but no later than the end of the exam period. The instructor may assign a grade of INC (incomplete) for the affected course if that is appropriate. In this case, the student must contact the instructor in order to determine how the course is to be completed. This will usually mean writing the exam when the course is next offered, but the instructor may choose to arrange for a deferred exam. In exceptional circumstances, the instructor may assign a grade of AEG (Aegrotat, credit granted, but no mark assigned because of illness). Students should note that poor performance during the term can easily cause an INC not to be granted.

12.3 Medical Certificates
The certificate should describe the nature of the illness, the degree of incapacity, and the precise period of absence or incapacitation. If an off-campus doctor is consulted, the "Verification of Illness" form should be completed.

13. Policies Concerning Courses

13.1 Course Load Policy

The standard course load for students in the Mathematics Faculty is five courses per term (2.5 units). The maximum load that may be taken without special permission is 2.75 units, allowing for five 0.5-unit courses and one 0.25-unit course. Exceptions to this normal load are as follows:

- Students who have a cumulative average of 80% or more may request permission from their advisor to enrol in a sixth course. The intention is to permit students to take additional courses beyond the 40 course (20 unit) degree requirement and thereby gain greater breadth in their education. However, honours co-op students should not enrol in six courses with a view to graduating in fewer than eight terms, since it is Faculty policy that co-op students must complete eight full-time terms in order to graduate with an honours degree.
- If a student has courses with INC grades on his/her record, the total unit weight of those INC courses and the courses enrolled for the current term may not normally exceed 3.25 units. A student may obtain permission from an academic advisor to exceed this limit, if an INC will not be completed in the current term because the course is not offered.
- Students with a CAV < 60% or whose excluded units exceed half their non-excluded passed units (such students would normally be on "Academic Probation" or in "Marginal Standing") are restricted to a course-load maximum of 2.25 units for the subsequent academic term.
- If more than one of the preceding apply to a student, the maximum course load is the smallest of the limits specified.

Students may add new courses or change sections in already scheduled courses no later than the end of the second week of lectures. Students must complete their add or swap activity on Quest or submit a "Course Override Form" to the Mathematics Undergraduate Office by the published deadline.

13.2 Course Prerequisites

At any time prior to the completion of lectures, if it is discovered that a student is taking a course offered by the Faculty of Mathematics without having previously completed the course prerequisites stated in the University Undergraduate Calendar or having been granted a requisite override for the course, the student is subject to having his/her registration in that course purged from university records. Such purging may be done at the request of the course instructor, the department offering the course, and/or the Faculty of Mathematics, but not without the consent of the instructor. A course must have been passed to be used as a prerequisite. In particular, if the course grade is currently INC or UR, the course may not be used as a prerequisite.

13.3 No-Credit/Overlap Courses

Some courses offered within the University may not be taken for credit towards a degree offered through the Faculty of Mathematics, since they have been designed for students in faculties other than Mathematics. These courses are identified on the "Course No-Credit List." Other courses offered by various departments throughout the University deal with similar subject matter. In these instances, at most one entry from a group of overlapping courses may count for credit towards their BCS, BCFM, or BMath degree. These courses are identified on the "Course Overlap List." It is the student’s responsibility to be aware of the contents of these lists.

13.4 Courses While on a Co-op Work Term

Co-op students on a work term are limited to one course (0.5 units), unless they have written support from their employer to take two courses (1.0 units).

13.5 Courses at Other Universities (Letters of Permission)

Students "In Good Standing" are normally permitted to take non-math courses at other universities on a part-time basis during terms off campus, provided the courses are not explicitly required for their particular plan. Students wishing to take courses at other universities must submit a completed "Letter of Permission Form" to the Registrar’s Office before taking each course. The Standings and Promotions (SGP) Committee will not approve courses taken elsewhere for BCS, BCFM, or BMath degree credit if prior approval has not been obtained.

Courses taken on a Letter of Permission will be recorded on a student’s academic record as transfer credits (T) or transfer failures (TF) as appropriate. A grade of 60 or higher will be recorded as a credit and a grade of less than 50 will be recorded as a failure. Grades of 50-59 will result in the course not being recorded on a student’s record. Co-op students on work terms are limited to one course (0.5 units), unless they have written support from their employer to take two courses (1.0 units).

It will be the student’s responsibility to ensure that an official transcript from the host institution is sent to the UW Registrar’s Office within two months of the completion of the course. Otherwise, a transfer failure will be automatically recorded. Any changes a student wishes to make to an authorized Letter of Permission must be approved in advance by the Standings and Promotions (SGP) Committee.

14. Co-op Regulations

14.1 Co-op Degree Requirements

Co-operative mathematics students are expected to follow the normal alternating academic/work-term sequence appropriate to their plan from admission through to graduation (see "Study/Work Sequence" section). Students admitted at the 1A level, with the exception of those in the Mathematics/Chartered Accountancy and BBA/BMath Double Degree plans, will normally have eight academic terms and six work terms. Such students must successfully complete all academic degree requirements including five professional-development courses, write at least four satisfactory work reports, and follow an approved academic/work-term sequence, which will normally include at least five satisfactory work terms.
Students may not end their academic/work-term sequence with a work term. Students must satisfy all honours degree course requirements within one calendar year after the termination of their approved academic/work-term sequence, or they will normally be eligible only for a regular honours degree.

14.2 Co-op PD Course and Work Report Regulations

The required schedule for completing the PD course and work report requirements is as follows:

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<thead>
<tr>
<th>By end of work term</th>
<th>Normal Number of credited PD courses</th>
<th>Minimum number of credited PD courses</th>
<th>Normal number of credited work reports</th>
<th>Minimum number of credited work reports</th>
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- If a co-op student fails to submit a work report, he/she will receive a grade of NCR.
- If a co-op student accumulates two grades of NCR for work reports, he/she will be required to withdraw from the co-op system of study.
- If a co-op student accumulates three grades of NCR for PD courses, he/she will be required to withdraw from the co-op system of study.
- If a co-op student accumulates a combined total of four grades of NCR for PD courses and work reports, the student will be required to withdraw from the co-op system of study.

14.3 Re-arranging Academic/Work-term Sequences

Student requests to re-arrange academic/work-term sequences must be directed to the Standings and Promotions (SGP) Committee on the "Academic/Work Term Sequence Change Form" available from Co-operative Education and Career Service and the Mathematics Undergraduate Office. Such requests will normally be approved if all of the criteria listed on the form are met. Students who alter their academic/work-term sequence without first obtaining written approval may be required to withdraw from the co-op system. It is the student’s responsibility to deal with any timetabling difficulties which may arise and select courses for subsequent terms.

15. Transfer Students

15.1 Residency/Registration Requirement

Students must normally complete at least 50% of the minimum number of math courses and at least 50% of the total number of units required for a degree offered through the Faculty of Mathematics while registered in the Faculty. Students transferring into a co-op system of study must complete at least five work terms (unless otherwise stipulated by plan requirements); at least three of these must be successfully completed while registered in the Mathematics Faculty. At least two of the required five PD courses and two of the four required work reports must be submitted while registered in the Faculty of Mathematics.

15.2 Transfer Credits

Transfer students will normally be given transfer credit for relevant courses taken previously if (i) a mark of at least 60% or equivalent has been obtained, (ii) a mark of at least 50% has been obtained in a University of Waterloo non-math course or in a University of Waterloo mathematics course specifically designated for mathematics students. Credit may not be granted for a course covering only part of the material contained in a corresponding required UW course. Grades for transferred courses will not count in averages.

15.3 Transferring into a Co-op System of Study

Late transfers to the co-op system of study are considered once per term. Admission is very competitive and is a function of availability and demonstrated academic performance at the university level.

Regular students in the Faculty of Mathematics may apply to transfer to the co-op system of study in their 1B term. To be eligible, at the time of admission to co-op such students must have successfully completed between 4.0 and 6.0 units, including transfer credits.

Co-op students from other faculties at the University of Waterloo may apply to transfer to the co-op system in the Faculty of Mathematics at the end of any term provided they can satisfy the residency/registration requirement specified in 15.1.

Students external to the University of Waterloo who are not from a co-op program at their home university may apply to transfer to the co-op system in the Faculty of Mathematics. To be eligible, at the time of admission such students will have successfully completed no more than 3.0 units of math transfer credits and between 4.0 and 6.0 units of transfer credits in total.

Students external to the University of Waterloo who are from a co-op program at their home university may apply to transfer to the co-op system of study in the Faculty of Mathematics. Such applications will be considered on a case-by-case basis.

15.4 Transfer into a Computer Science Major Plan
Please see the Computer Science admission requirements section.

16. Double Counting of Courses for BCS, BCFM, or BMath Degree Credit
With the exception of specially approved double degree plans (e.g., BBA/BMath Double Degree plan with WLU), the Faculty of Mathematics does not allow students to have more than 50% of the course units that they are counting for Mathematics Faculty degree credit be ones that have previously been used, or that are being used simultaneously, to obtain a second degree from another UW faculty or from another university.