MA by Survey Paper
Three 6000-level full courses (or equivalent), a supervised survey paper (Mathematics & Statistics 6001 0.0; students give one talk in a student Colloquium outlining the results of their papers), plus a seminar† (Mathematics & Statistics 6004 0.0).

MA by Thesis
Two 6000-level full courses (or equivalent), a thesis (students give two talks in a student Colloquium outlining the results of their theses), plus a seminar† (Mathematics & Statistics 6004 0.0). The thesis must be defended before an examining committee in accordance with the regulations of the Faculty of Graduate Studies.

Whatever option is chosen, no more than one-third of courses can be integrated, and all students must include among their courses one of the following sets:

i) Pure Mathematics:
Mathematics & Statistics 6121 3.0: Applied Algebra,
Mathematics & Statistics 6122 3.0: Algebra II,
Mathematics & Statistics 6461 3.0: Functional Analysis I, and either
Mathematics & Statistics 6280 3.0: Measure Theory,
Mathematics & Statistics 6300 3.0: Complex Analysis,
Mathematics & Statistics 6420 3.0: Introduction to Harmonic Analysis,
Mathematics & Statistics 6462 3.0: Functional Analysis II,
Mathematics & Statistics 6540 3.0: Topology I,
Mathematics & Statistics 6550 3.0: Algebraic Topology I or
Mathematics & Statistics 6605 3.0: Probability Theory; or

ii) Applied Mathematics:
Four courses chosen from
Mathematics & Statistics 6121 3.0: Applied Algebra,
Mathematics & Statistics 6340 3.0: Ordinary Differential Equations,
Mathematics & Statistics 6350 3.0: Partial Differential Equations,
Mathematics & Statistics 6602 3.0: Stochastic Processes,
Mathematics & Statistics 6604 3.0: Probability Models,
Mathematics & Statistics 6651 3.0: Advanced Numerical Methods,
Mathematics & Statistics 6652 3.0: Numerical Solutions to Differential Equations,
Mathematics & Statistics 6904 3.0: Modern Optimization,
Mathematics & Statistics 6910 3.0: Stochastic Calculus in Finance,
Mathematics & Statistics 6911 3.0: Numerical Methods in Finance,
Mathematics & Statistics 6920 3.0: Harmonic Analysis and Image Processing,
Mathematics & Statistics 6931 3.0: Mathematical Modeling,
Mathematics & Statistics 6936 3.0: Mathematical Epidemiology; or

*Students may substitute another half course for the seminar if they are pursuing their MA by Survey Paper or by Thesis. Students completing their MA by Coursework can replace the seminar requirement with another half course only if one of their four courses toward the degree is the practicum in statistical consulting (Mathematics & Statistics 6627 3.0).
iii) Probability:
Mathematics & Statistics 6910 3.0: Stochastic Calculus in Finance;
   either
Mathematics & Statistics 6605 3.0: Probability Theory or
Mathematics & Statistics 6280 3.0: Measure Theory;
   either
Mathematics & Statistics 6602 3.0: Stochastic Processes or
Mathematics & Statistics 6604 3.0: Probability Models;
   and one of
Mathematics & Statistics 6620 3.0: Mathematical Statistics,
   Mathematics & Statistics 6630 3.0: Applied Statistics I or
Mathematics & Statistics 6911 3.0: Numerical Methods in Finance; or

iv) Theoretical Statistics:
Mathematics & Statistics 6620 3.0: Mathematical Statistics,
   Mathematics & Statistics 66213.0: Advanced Mathematical Statistics or
Mathematics & Statistics 6605 3.0: Probability Theory,
   Mathematics & Statistics 6622 3.0: Generalized Linear Models,
   Mathematics & Statistics 6630 3.0: Applied Statistics I; or

v) Applied Statistics:
Mathematics & Statistics 6620 3.0: Mathematical Statistics,
   Mathematics & Statistics 6622 3.0: Generalized Linear Models,
   Mathematics & Statistics 6630 3.0: Applied Statistics I,
   either,
Mathematics & Statistics 6631 3.0: Applied Statistics II or
Mathematics & Statistics 6635 3.0: Introduction to Bayesian Statistics or
Mathematics & Statistics 6641 3.0: Survival Analysis or
Mathematics & Statistics 6642 3.0: Applied Longitudinal Data Analysis, and
Mathematics & Statistics 6627 3.0: Practicum in Statistical Consulting; or

vi) Data Science
Mathematics & Statistics 6620 3.0: Mathematical Statistics,
   Mathematics & Statistics 6622 3.0: Generalized Linear Models,
   Mathematics & Statistics 6630 3.0: Applied Statistics I,
   Mathematics & Statistics 6650 3.0: Data Science, and
   either Mathematics & Statistics 6636 3.0: Data Mining or
Mathematics & Statistics 6644 3.0: Statistical Learning.

Students may, with permission, use courses from other graduate programs such as Electrical Engineering & Computer Science, Economics or Physics & Astronomy to meet the requirements.

PROGRAM LENGTH
The expected degree completion time for full-time master’s students is 6 terms. For those students who complete degree requirements earlier than 6 terms, they must register and pay fees for a minimum of the equivalent of 6 terms of full-time study. All requirements for a master’s degree must be fulfilled within 12 terms (4 years) of registration as a full-time or part-time master’s student in accordance with Faculty of Graduate Studies’ registration policies.

MASTER OF SCIENCE IN APPLIED & INDUSTRIAL MATHEMATICS
ADMISSION REQUIREMENTS
An honours degree in mathematics (or equivalent background) normally with a B standing may qualify the student for admission as a candidate to the program leading to the MSc degree in Industrial & Applied Mathematics. Applicants without the appropriate breadth in mathematics, but who have good standing, may be admitted on condition they take additional graduate and/or undergraduate courses. Faculty of Graduate Studies regulations regarding standing (see Grading System under Faculty Regulations) apply to these additional courses. Students whose first language is not English must demonstrate an acceptable command of English (at least 213 in the Test of English as a Foreign Language or 85 in the Michigan English Language Assessment Battery).

DEGREE REQUIREMENTS
Students must complete Mathematics & Statistics 6651 3.0: Advanced Numerical Methods, Mathematics & Statistics 6931 3.0: Mathematical Modeling, Mathematics & Statistics 6937 3.0: Practicum in Industrial & Applied Mathematics, another three credit non-integrated course appropriate to the student’s program of study approved by the student’s supervisory committee, and a thesis which must be defended before an examining committee in accordance with the regulations of the Faculty of Graduate Studies.

PROGRAM LENGTH
The expected degree completion time for full-time master’s students is 6 terms. For those students who complete degree requirements earlier than 6 terms, they must register and pay fees for a minimum of the equivalent of 6 terms of full-time study. All requirements for a master’s degree must be fulfilled within 12 terms (4 years) of registration as a full-time or part-time master’s student in accordance with Faculty of Graduate Studies’ registration policies.

GRADUATE DIPLOMA IN FINANCIAL ENGINEERING
ADMISSION REQUIREMENTS
The Graduate Diploma in Financial Engineering is completed either in conjunction with the regular master’s or doctoral program in Mathematics & Statistics, or as a standalone graduate diploma. For the concurrent offering, students must first apply and be accepted to the regular master’s or doctoral program in Mathematics & Statistics. Applicants may indicate their interest in pursuing the concurrent Graduate Diploma in Financial Engineering at the same time they apply to the regular master’s or doctoral program in Mathematics & Statistics, or they may submit a separate application for the diploma during the first term in which they are registered in the regular master’s or doctoral program.

For the stand-alone diploma offering, see the Business Administration section of this Calendar.

DIPLOMA REQUIREMENTS
The requirements for the concurrent Graduate Diploma in Financial Engineering may be completed in conjunction with the MA by Coursework or MA by Survey Paper program requirements.

The requirements for the diploma are as follows:
A) Successful completion of the following courses:
Mathematics & Statistics 6910 3.0: Stochastic Calculus in Finance
Mathematics & Statistics 6911 3.0: Numerical Methods in Finance
Finance 6200 3.0: Investments
Finance 6800 3.0: Options, Futures and Other Derivative Securities
Financial Engineering 6820 3.0: Advanced Derivative Securities
Financial Engineering 6850 3.0: Fixed Income Securities
Operations Management & Information Systems 6000 3.0: Models and Applications in Operational Research

Note 1: Mathematics 6910 3.0, Mathematics 6911 3.0, and Operations Management & Information Systems 6000 3.0, may be used to satisfy the MA by Coursework or MA by Survey Paper program requirements.

Note 2: Students with little or no background in finance may find it beneficial to take Economics 5030 3.0: Econometrics of Financial Markets, as background for the finance courses listed above.

b) In addition to the course requirements, diploma students must complete one of the following: (i) subject to availability, an internship of at least 10 weeks duration in a financial institution, or (ii) a research project.

Note: Students in the MA by Survey Paper program option who decide to fulfill the above requirement through completion of a research project may request that the diploma research project also be used toward the fulfillment of the MA survey paper requirement. Such requests must be made in writing to the Financial Engineering Coordination Committee, accompanied by confirmation from the student's faculty advisor that the diploma research project is of acceptable quality to meet the MA by Survey Paper program requirements. Such requests will be considered by the Financial Engineering Coordination Committee only if the diploma research project contains substantial mathematics content, equivalent to that expected of students in the MA by Survey Paper program option.

c) Diploma seminar requirement: Students who did not complete Mathematics 6627 3.0: Practicum in Statistical Consulting, as part of their Mathematics & Statistics degree program requirements are required to give a talk on their internship or research paper to fulfill the diploma seminar requirement. Such students should enrol in Mathematics 6004 0.0: Mathematics Seminar in order to receive a grade.

Diploma Length
Students typically require four consecutive terms to complete coursework for the Mathematics & Statistics degree program and Type 2 Graduate Diploma in Financial Engineering, and then go on to complete the internship or research project, normally in one term.

DOCTOR OF PHILOSOPHY PROGRAM
ADMISSION REQUIREMENTS
For admission to the PhD program, applicants must have completed an acceptable master’s degree in mathematics or statistics with a B+ average (high second class) or better.

DEGREE REQUIREMENTS
Candidates for the PhD degree must fulfil the following requirements:

Five major components make up the degree requirements for the PhD in Mathematics and Statistics. These are 1) coursework 2) comprehensive exams 3) dissertation subject oral 4) dissertation proposal 5) dissertation oral examination (preceded by the dissertation colloquium).

Students can complete these degree requirements in four years and the following is the projected timeline and checklist for completion:

Course Requirements
Students must successfully complete 12 credits at the graduate level. The courses must be chosen with the approval of the program director. Up to 12 additional credits may be required, at the discretion of the Graduate Program Director, the PhD committee and the supervisor.

Comprehensive Examinations
Students must declare a specialization in pure mathematics or applied mathematics or statistics, and must write comprehensive examinations in subjects which are appropriate to the chosen specialization. In addition, statistics students must complete a statistical consulting requirement.

Specialization Requirement
Students in the PhD program must demonstrate depth of knowledge in their field of specialization. The candidate must pass an oral examination, which is given within one year after the comprehensive examinations have been passed.

Projected Timeline/Checklist for Completion

<table>
<thead>
<tr>
<th>Progress requirements</th>
<th>Completed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advising appointment</td>
<td>Annual</td>
</tr>
<tr>
<td>Progress report</td>
<td>Annual</td>
</tr>
<tr>
<td>Comprehensive exams</td>
<td>End of 3rd term</td>
</tr>
<tr>
<td>Supervisor confirmed</td>
<td>End of 5th term</td>
</tr>
<tr>
<td>Course requirements</td>
<td>End of 6th term</td>
</tr>
<tr>
<td>Supervisory committee approved</td>
<td>End of 6th term</td>
</tr>
<tr>
<td>Dissertation subject oral</td>
<td>End of 6th term</td>
</tr>
<tr>
<td>Statistics practicum/comprehensive exam</td>
<td>(Statistics stream only) End of 6th term</td>
</tr>
<tr>
<td>Dissertation proposal</td>
<td>No less than 6 months before oral examination</td>
</tr>
<tr>
<td>Dissertation colloquium</td>
<td>Normally 12th term</td>
</tr>
<tr>
<td>Oral examination</td>
<td>Normally 12th term</td>
</tr>
</tbody>
</table>

The details of these requirements are listed below:

A doctoral candidate must satisfy their comprehensive examination requirement by completing the examinations in the first year of study. Students need not enrol in the course nor attend lectures in order to write the examination for comprehensive credit. The comprehensive exams are as follows:

1. Mathematics & Statistics 6300 3.0: Complex Analysis
2. Mathematics & Statistics 6280 3.0: Measure Theory
5. Mathematics & Statistics 6122 3.0: Algebra II
6. Mathematics & Statistics 6130 3.0: Commutative Algebra
7. Mathematics & Statistics 6540 3.0: Topology
8. Mathematics & Statistics 6550 3.0: Algebraic Topology
9. Mathematics & Statistics 6340 3.0: Ordinary Differential Equations
11. Mathematics & Statistics 6110 3.0: Number Theory
13. Mathematics & Statistics 6180 3.0: Category Theory
15. Mathematics & Statistics 6040 3.0: Set Theory
17. Mathematics & Statistics 6652 3.0: Numerical Solutions to Differential Equations
18. Mathematics & Statistics 6931 3.0: Mathematical Modeling
21. Mathematics & Statistics 6622 3.0: Generalized Linear Models

Note: While not all courses are offered annually, course offerings are responsive to student need. Examinations may be taken in a year in which the course is not offered.

Candidates must declare themselves to be in one of these three streams: applied mathematics, pure mathematics, or statistics streams. Candidates decide which comprehensive exams to complete with the approval of their supervisor and the Graduate Program Director.

Pure mathematics students must complete at least one examination from 1-3, one examination from 4-6, one examination from 7-11, plus one additional examination.

Applied mathematics students must complete examination 18, at least one examination from 9 or 10, at least one examination from 16 or 17, plus one additional examination.

Statistics students must complete exams 19, 20, 21 and 22. In addition, statistics students must fulfill a practicum requirement. This requirement is usually completed in the second year of study.

Practicum requirement for statistics stream
The purpose of the practicum is to prepare students for the transition from statistics theory to the application of statistics through consulting and collaboration. The requirement for statistics students consists of two parts. The first part is the completion of Mathematics & Statistics 6627 3.0 or an equivalent consulting course from another university, approved by the Graduate Program Director. Further details regarding the requirements for the course can be found in the course description for Mathematics & Statistics 6627 3.0. The second part is the comprehensive examination in consulting.

Students in the doctoral program must demonstrate depth of knowledge in their field of specialization. The candidate must pass an oral examination (the dissertation subject oral), which occurs within the second year of study.

Progress Report
All students enrolled in a PhD program are required to complete an annual research progress report detailing the achievements of the previous year and the objectives for the next year. Permission to continue to register in the program depends on a satisfactory report. Progress report forms are distributed by email at the end of the Winter term.