Graduate Calendar

Mathematics and Statistics

2026-2027

YORK U



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Graduate Program Contact

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Orientation for Incoming Graduate Students

(TENTATIVE) September 11, 2026

Faculty of Graduate Studies regulations, important dates, and deadlines:

yorku.ca/gradstudies/

Graduate Program in Mathematics and Statistics:

yorku.ca/science/mathstats/graduate-programs/

Introduction

York University offers the following graduate programs in mathematics and statistics which lead to Master of Arts, Master of Science, or Doctor of Philosophy degrees:

- The MA program with specialization in applied mathematics, pure mathematics, probability, theoretical statistics, applied statistics, or data science.
- The MSc program in applied & industrial mathematics.
- The doctoral program in applied mathematics, pure mathematics, or statistics.

Students who are enrolled in the MA program can also apply for a graduate diploma in financial engineering.

This calendar describes these programs and provides details of entrance and degree requirements. It also provides information about support available to graduate students, as well as outlines of graduate courses to be offered in the coming academic year.

Summary of Graduate Programs

THE MA PROGRAM

This program is suitable for those students who wish to undertake graduate study in mathematics or statistics. To be admitted, students must hold an honours degree in mathematics or statistics, or have an equivalent background.

Students can take courses in a wide variety of fields. Courses in areas such as algebra, analysis, topology, differential equations, numerical methods, applications of logic and set theory, probability, operations research, mathematical modelling and applied statistics are offered regularly.

The program provides solid preparation for admission to a PhD program at York or other North American universities. It is also a suitable program for students who wish to expand their knowledge of mathematics or statistics beyond what they have learned at the undergraduate level, but may not desire to continue beyond the master's level.

The program is available on a full-time or part-time basis. Full-time students with a good background can usually complete their degree in three terms (i.e., fall, winter and summer terms). Full-time students who are not able to complete the degree requirements within three terms can continue to do so, but their status changes to part-time, with a maximum of three additional terms to complete the degree requirement.

THE MSC PROGRAM IN APPLIED & INDUSTRIAL MATHEMATICS

The MSc in applied & industrial mathematics has been designed as a two-year program including a thesis. Students are required to take a certain set of core courses and the practicum. In the practicum, students will model physical problems that involve interpretations of experimental data, mathematical formulation of problems, analyses of the mathematical problems, and interpretations of the results. The program will culminate in a thesis.

THE GRADUATE DIPLOMA IN FINANCIAL ENGINEERING

This program is a collaborative program established through the cooperation of the Schulich School of Business and the Department of Mathematics & Statistics. This diploma is awarded concurrently with a master's degree in mathematics & statistics. Financial engineering is one of the fastest growing areas of applied mathematics. The Financial Engineering Diploma program allows students to acquire both the theoretical knowledge and specialized skills needed to develop new financial instruments. Students who successfully complete this program find careers in the financial sector. For more information, contact diploma coordinator Michael Chen (chensy@yorku.ca).

THE PHD PROGRAM

Students in the PhD program take advanced level courses and write a dissertation containing original research results. Members of the program have expertise in a wide variety of areas in mathematics, statistics and related disciplines.

A detailed listing of the faculty and their fields of interest available at: yorku.ca/science/mathstats/faculty-and-instructors/.

To be admitted as a PhD student, an applicant must have a master's degree in mathematics or statistics, or must have completed at least one year of comparable studies.

Program Regulations

General Admission Requirements

To be considered for admission to the graduate program in mathematics and statistics, an applicant must be a graduate of a recognized university, or have equivalent qualifications. The average of a previous degree is normally calculated based on relevant grades over the last two years of study. In practice, applicants who are admitted usually have a higher average than the stated minimum requirement for each degree in this calendar, especially in their mathematics and statistics courses.

Applicants are required to demonstrate competence in English if they come from a country/institution where English is not the main language. A minimum score of 80 (TOEFL IBT) or 6.5 (IELTS Academic Module) is required.

Applicants are not required to take the Graduate Record Examinations (GRE).

THE MA PROGRAM

Admission Requirements

See the section on General Admission Requirements. To be considered for admission in the MA program, the student must have a minimum average of B- (minimum score of 70 out of 100), although applications are competitive, and in practice successful applicants usually have a GPA of at least B+ (minimum score of 77 out of 100). In addition to having sufficiently high standing, students are expected to have completed certain core courses in mathematics or statistics as undergraduates.

Degree Requirements

Students may complete the degree in one of three options of course-based program, combination of course and survey paper, or combination of course and thesis. Based on the chosen option, the student may also need to complete the seminar requirement. No more than one-third of the courses used to meet the credit requirement can be integrated with undergraduate courses, and more details on the Survey Paper and the Thesis are given below.

- *MA by Coursework* requires
  - 24 credits of 6000-level courses
  - and MATH 6004 Seminar
- *MA by Survey Paper* requires
  - 18 credits of 6000-level courses
  - MATH 6001 Survey Paper
  - and MATH 6004 Seminar*
- *MA by Thesis* requires
  - 12 credits of 6000-level courses
  - an MA thesis with defence
  - and MATH 6004 Seminar

* Students who are completing the MA by Survey Paper or Thesis may, with the approval of the GPD, substitute an additional 6000-level course (beyond the above credit requirement) for 6004

Core Courses Requirements

In completing the degree requirements, each student is required to complete the core courses of one of the streams listed below. In other words, the courses taken to meet the number of credits required above must contain one of the six sets of core courses listed below. Students may find the MA program worksheets to be a more user-friendly format for this information. Note that not all courses are offered in every year.

Pure Mathematics Stream

- Applied Algebra (Math 6121 3.0)
- Algebra II (Math 6122 3.0)
- Functional Analysis I (Math 6461 3.0)
- and one of the following
  - Analytic Number Theory (Math 6110 3.0)
  - Algebraic Number Theory (Math 6115 3.0)

- Measure Theory (Math 6280 3.0)
- Complex Analysis (Math 6300 3.0)
- Introduction to Harmonic Analysis (Math 6420 3.0)
- Functional Analysis II (Math 6462 3.0)
- Topology I (Math 6540 3.0)
- Algebraic Topology I (Math 6550 3.0)
- Probability Theory (Math 6605 3.0)

Applied Mathematics Stream

Four courses chosen from

- Applied Algebra (Math 6121 3.0)
- Ordinary Differential Equations (Math 6340 3.0)
- Partial Differential Equations (Math 6350 3.0)
- Stochastic Processes (Math 6602 3.0)
- Probability Models (Math 6604 3.0)
- Advanced Numerical Methods (Math 6651 3.0)
- Numerical Solutions to Differential Equations (Math 6652 3.0)
- Modern Optimization (Math 6904 3.0)
- Stochastic Calculus in Finance (Math 6910 3.0)
- Numerical Methods in Finance (Math 6911 3.0)
- Harmonic Analysis and Image Processing (Math 6920 3.0)
- Mathematical Modelling (Math 6931 3.0)
- Mathematical Epidemiology (Math 6936 3.0)
- Stochastic Programming (MATH 6902 3.0)
- Machine Learning in Finance (MATH 6912 3.0)
- Data-driven Finance with Python (MATH 6914 3.0)
- Computational Methods in Mathematical Biology (Math 6671 3.0)

Probability Stream

- Stochastic Calculus in Finance (Math 6910 3.0)
- one of
  - Probability Theory (Math 6605 3.0)
  - Measure Theory (Math 6280 3.0)
- one of
  - Stochastic Processes (Math 6602 3.0)
  - Probability Models (Math 6604 3.0)
- and one of
  - Mathematical Statistics (Math 6620 3.0)
  - Applied Statistics I (Math 6630 3.0)
  - Numerical Methods in Finance (Math 6911 3.0)

Theoretical Statistics Stream

- Mathematical Statistics (6620 3.0)
- Generalized Linear Models (6622 3.0)
- Applied Statistics I (6630 3.0)
- and one of
  - Advanced Mathematical Statistics (6621 3.0)
  - Probability Theory (6605 3.0)

Applied Statistics Stream

- Mathematical Statistics (6620 3.0)
- Generalized Linear Models (6622 3.0)
- Applied Statistics I (6630 3.0)
- Practicum in Statistical Consulting (6627 3.0)
- and one of
  - Applied Statistics II (6631 3.0)
  - Introduction to Bayesian Statistics (6635 3.0)
  - Survival Analysis (6641 3.0)
  - Applied Longitudinal Data Analysis (Math 6642 3.0)

Data Science Stream

- Mathematical Statistics (6620 3.0)
- Generalized Linear Models (6622 3.0)
- Applied Statistics I (6630 3.0)
- Data Science (6650 3.0)
- and one of

- Data Mining (6636 3.0)
- Statistical Learning (6644 3.0)

Thesis, Survey Paper, and Seminar Requirements

Seminar requirement (MATH 6004)

In addition to the above, students who choose option (i)-(iv) or (vi) as their core course requirement must fulfil the seminar requirement (Math 6004 0.0). Students who choose option (v) are exempt as they do the course of the Practicum in Statistical Consulting (Math 6627 3.0) in place of the seminar. To fulfill the seminar requirement, students must present two one-hour seminar presentations. For each seminar, the student must find a faculty member to supervise the seminar (different supervisor for each talk), and the topic is chosen in conjunction with the supervisor, who will then grade the talk on a pass-fail basis. Topics can be chosen from any branch of mathematics, but should not be taken directly from the student's course work, survey paper, or thesis, although they can be related to such materials. The two talks should be supervised by different faculty members, and the second should not be a continuation of the first.

Talks must be separated by at least one week, must be announced to the department at least 5 days before the talk is given, and must have at least 3 members of the York university community present in addition to the supervisor. In addition to giving the talks, students must attend six talks (e.g., seminar by other students). Documented evidence of attendance for each of the six talks is required.

It is not necessary to complete all of the components of 6004 in one semester; students should register in MATH 6004 in the term in which they complete the last talk of the 6004 requirements.

Students may substitute another half-course for the seminar (Math 6004) if they are pursuing their MA by Survey Paper (Math 6001) or by Thesis.

Survey paper (MATH 6001)

The student must submit a survey paper (Math 6001 0.0) written under a faculty advisor and give a 50-minute oral presentation with a half-hour question and answer period. A digital copy (in PDF format) of the final version of the survey paper, with the confirmation of the faculty advisor, must be submitted to the program (gradmath@yorku.ca) within one week after the oral presentation.

Thesis option

The student must write a master's thesis under the supervision of an approved faculty member and defend it before an examining committee in accordance with Faculty of Graduate Studies procedures. In addition to Faculty regulations regarding thesis examination, the candidate gives two talks in a student colloquium (20-minute presentation followed by question and answer period), one outlining work in progress and one presenting the final results. These talks are given prior to the final thesis defense.

In order to establish a committee for the thesis, a student will find a supervisor and at least one other faculty member to form the committee, and request approval of this committee via the FGS portal.

Before beginning the thesis research, and no later than the end of the second term, the student must submit a thesis proposal (with bibliography) and TD-1 ethics form via the FGS milestone portal. Note that a thesis cannot be defended until at least 3 months after the thesis proposal has been approved. Further details on the preparation and defence of a master's thesis are provided on the Faculty of Graduate Studies website.

The defence of the thesis is scheduled via the Request for Oral Exam section of the FGS portal, and should be initiated at least 20 business days before the planned defence date. Please see FGS Important Dates to

check the deadlines for defending in order to graduate in a given term.

At the final defence, the student will give an oral presentation (30-minute presentation and one-and-half hours question and answer period) to defend the thesis before the examining committee.

It is the responsibility of both the supervisor and the student to ensure that all degree requirements are met.

Additional Information on Required Courses

The courses selected to meet the above requirements of additional course credits must be graduate-level Math courses with first digit 6 (referred to as 6000-level courses). Students may, with permission from the graduate program director, use courses in other graduate programs such as computer science, physics and astronomy or economics to meet the requirements.

No more than one third of the credits counted towards the MA degree requirements can come from integrated courses. Students will also not take or receive credit for an integrated course at the graduate level if they previously took the undergraduate version at York or elsewhere.

Additional Information on Survey Paper and Seminar for MA Program

What is expected from students in survey paper?

Students are expected to identify a faculty member who agrees to supervise them for a survey paper. A final report of the survey paper, approved by the supervisor, must be submitted digitally (in PDF format) to the graduate program (gradmath@yorku.ca) along with the confirmation of the faculty supervisor.

› *How to find a supervisor*?

While the program will make efforts to provide the necessary support, students are responsible for finding their own supervisor for seminar and/or survey paper.

› *How are grades reported*?

The grade for the survey paper is pass or fail, and must be submitted by the following dates:

- Fall Term: January 15 (3.0 or 6.0 credit course)
- Fall/Winter and Winter Term: May 15 (3.0 or 6.0 credit course)
- Summer Term: September 15 (3.0 or 6.0 credit course)

› *How to confirm attendance in a seminar*?

The host (generally a faculty member) must sign the attendance form found at:

yorku.ca/science/mathstats/wp-content/uploads/sites/62/2021/04/Seminar_Attendance.pdf

This form must be submitted within a week of the seminar to the graduate program

(gradmath@yorku.ca).

› *What is acceptable as a seminar*?

Students can attend seminars by other students or faculty members, colloquia, DSO of PhD students, and thesis or dissertation defence.

Note: MA students who are taking Math 6001 (Survey Paper) or Math 6004 (Seminar) should enrol in the term of completion.

Additional Information on Registration

Full-time MA students must register and pay fees for a minimum of three terms.

If MA program is not completed with 3 semesters of full-time study, the status of an MA student will be automatically part-time for any additional terms. Part-time students are not eligible for funding. Note that registration in Financial Engineering Diploma **will not** extend the period of full-time study in the MA program.

Part-time MA students must register and pay fees for a minimum of 6 terms.

Full-time students may not be absent from the campus without the permission of the program

director for more than four weeks of any term in which they are registered.

Academic Standing

Students who receive a grade of C in three 3-credit courses, or one C and one F, will be deemed by Faculty of Graduate Studies to have fallen out of good academic standing, and face withdrawal from the program.

Funding Note

Because of stipulations in the TA contract, it can happen that not enough of the funding package is deposited into your student account, and too much is deposited in your bank account, leading to an amount owing on your student account. The total funding is paid out, but as you can imagine it is an unpleasant surprise for students who find out that not all of their fees were payed automatically. Please check your student account regularly, to make sure that there is no amount owing.

THE MSC PROGRAM IN APPLIED & INDUSTRIAL MATHEMATICS

Admission Requirements

An honours degree in mathematics (or equivalent background) with a minimum average of B (minimum score of 73 out of 100) may qualify the student for admission as a candidate to the program leading to the MSc degree in applied & industrial mathematics. Students whose first language is not English must demonstrate an acceptable command of English. A minimum score of 80 (TOEFL IBT) or 6.5 (IELTS Academic Module) is required.

Degree Requirements

Students must complete

- Advanced Numerical Methods (Math 6651 3.0)
- Mathematical Modelling (Math 6931 3.0)
- Practicum in Industrial and Applied Mathematics (Math 6937 3.0)
- another 3-credit 6000-level course appropriate to the student's program of study approved by the student's supervisory committee
- and a thesis (see below) which must be defended before an examining committee in accordance with the regulations of the Faculty of Graduate Studies.

The student must write a master's thesis under the supervision of an approved faculty member and defend it before an examining committee in accordance with Faculty of Graduate Studies procedures. In addition, the candidate gives two talks in a student colloquium (20-minute presentation, followed by question and answer period), one outlining work in progress and one presenting the results. These presentations are completed prior to the final defense. All members of the supervisory committee must be present at both talks.

In order to establish a supervisory committee for the thesis, a student will find a supervisor and at least one other faculty member to form the committee, and request approval of this committee via the FGS portal.

Before beginning the thesis research, the student must submit a thesis proposal (with bibliography) and TD-1 ethics form via the FGS milestone portal. Note that a thesis cannot be defended until at least 3 months after the thesis proposal has been approved. Further details on the preparation and defence of a master's thesis are provided on the Faculty of Graduate Studies website.

The defence of the thesis is scheduled via the Request for Oral Exam section of the FGS portal, and should be initiated at least 20 business days before the planned defence date. Please see FGS Important Dates to check the deadlines for defending in order to graduate in a given term.

At the final defence, the student will give an oral presentation (30-minute presentation and one-and-half hours question and answer period) to defend the thesis before the examining committee.

It is the responsibility of both the supervisor and the student to ensure that all degree requirements are met.

Additional Information on Required courses

A student will not receive credit for more than 2 half integrated courses towards the master's degree. Students may not take or receive credit for an integrated course at the graduate level if they previously took it at York or elsewhere at the undergraduate level.

Additional Information on Registration

Full-time MSc students must register and pay fees for a minimum of 6 terms.

If MSc program is not completed with 6 semesters of full-time study, the status of an MSc student will be automatically part-time for any additional terms. Part-time students are not eligible for funding.

Part-time MSc students must register and pay fees for a minimum of 12 terms.

Academic Standing

Students who receive a grade of C in three 3-credit courses, or one C and one F, will be deemed by Faculty of Graduate Studies to have fallen out of good academic standing, and face withdrawal from the program.

Funding note

Because of stipulations in the TA contract, it can happen that not enough of the funding package is deposited into your student account, and too much is deposited in your bank account, leading to an amount owing on your student account. The total funding is paid out, but as you can imagine it is an unpleasant surprise for students who find out that not all of their fees were payed automatically. Please check your student account regularly, to make sure that there is no amount owing.

THE GRADUATE DIPLOMA IN FINANCIAL ENGINEERING (TYPE 2 - CONCURRENT)

Admission Requirements

The Graduate Diploma in Financial Engineering is completed in conjunction with the master's or doctoral program in mathematics and statistics. Students must first apply and be accepted to the MA, MSc, or doctoral program in mathematics and statistics.

Applicants may indicate their interest in pursuing the Graduate Diploma in Financial Engineering at the same time they apply to the MA, MSc or doctoral program in mathematics and statistics, or they may submit a separate application for the diploma during the first term in which they are registered in the master's or doctoral program. For further information and application process please visit the website.

Diploma Requirements

The requirements for the Graduate Diploma in Financial Engineering may be completed in conjunction with the master's program requirements.

Successful completion of the following courses

- MATH 6910 3.0, Stochastic Calculus in Finance and/or MATH 6914 3.0, Data-Driven Finance with Python
- MATH 6912 3.0, Machine Learning in Finance
- SB FINE 6200 3.0, Investments
- SB FINE 6800 3.0, Options, Futures, and Other Derivative Securities
- SB FNEN 6820 3.0, Advanced Derivative Securities
- SB FNEN 6850 3.0, Fixed Income Securities
- FNEN 6840 3.0 Enterprise-Wide Financial Risk Management

Note: MATH 6910, MATH 6912, MATH 6914, and OMIS 6000 may be used to satisfy the MA by Coursework or MA by Survey Paper (Math 6001) program requirements.

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

In addition to these courses, students must also complete one of the following:

- an internship of at least 10 weeks duration in a financial institution (subject to availability)
- a research project on FE
- MFIN 5700

Students in the MA program by Survey Paper (Math 6001) 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 fulfilment of the MA survey paper requirement. Such requests must be made in writing to the financial engineering coordinator, accompanied by the confirmation from the student's faculty advisor that the diploma research project is of acceptable quality to meet the MA degree requirements by Survey Paper. Such requests will be considered by the financial engineering coordinator only if the diploma research project contains substantial mathematics content, equivalent to that expected of students in the MA degree by Survey Paper option.

Finally, students must complete the diploma seminar requirement. Students who did not complete MATH 6627 3.0, Practicum in Statistical Consulting, as part of their mathematics and statistics degree program requirements are required to give a talk on their internship or research project to fulfill the diploma seminar requirement. These students should enrol in MATH 6004, Seminar course, in order to receive a grade. The talk must be announced to the department at least 5 days before the talk is given, and must have at least 3 members of the York university community present in addition to the supervisor. In addition to giving the talk, students must attend six talks of other students in the department. Documented evidence of attendance at six such talks is required (similar to the requirements of MA degree).

Diploma Length

Students typically require four consecutive terms to complete both the coursework for 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.

Additional inquiries may be communicated with the diploma program coordinator Michael Chen (chensy@yorku.ca).

THE PHD PROGRAM

The Department of Mathematics and Statistics offers PhD programs in applied mathematics, pure mathematics, and statistics.

Admissions Requirements

To be considered for admission in PhD programs, students must have completed an acceptable master's degree or must have completed one year of comparable work, with a minimum B+ average (minimum score of 77 out of 100). The admission process is very selective and not all students meeting this requirement will be admitted. A complete application file is required for the applicant to be considered.

Applicants should obtain at least two letters of recommendation by academics who know them well. Applications are considered by the PhD Committee, which ranks the applicants and makes recommendations to the graduate program director. The director will then make a recommendation to the Faculty of Graduate Studies for admission.

Current master's students who wish to apply for admission to the PhD program must submit an on-line application and supporting documentation. Internal promotion from master's to PhD program may be possible at the discretion of the graduate program director.

Degree 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; and (5) dissertation oral exam (proceeded by the dissertation colloquium). Students can complete these degree requirements in 4 years.

Course Requirements

Students must successfully complete 12 credits at the graduate level, chosen in collaboration with the supervisor and with the approval of the program director. Up to 12 additional credits may be required based on the recommendation of the supervisor, and at the discretion of the PhD committee and the graduate program director. Determination of such additional credits, if needed, will be made during the first semester of the PhD program and communicated with the students.

Note: A PhD student may submit a petition under the following circumstances.

- A required course has already been completed through a previous degree. The petition may request replacement of another 6000-level course to satisfy the requirements of the PhD program with the completion of a minimum of 12 credits.
- The contents of additional credits recommended by the program have been covered in previous courses successfully completed by the student. The petition may request to waive such additional credits.

A petition must be submitted within the first semester of the PhD program, and must be supplemented with detailed syllabus for each course. The graduate program director may require a letter of course equivalency for approval of the petition.

Note on course credits: Students will not take or receive credit for an integrated course at the graduate level if they previously took it at York or elsewhere at the undergraduate level.

Comprehensive Examinations

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

A doctoral candidate must satisfy their comprehensive examination requirements by completing the exams in the first year of study. Students need not enrol in the courses nor attend lectures in order to write the comprehensive exams. However, it is responsibility of the student to follow the syllabi of courses to prepare for the exams. The comprehensive exams in PhD programs include:

(1) Complex Analysis (MATH 6300)

(2) Measure Theory (MATH 6280)

(3) Functional Analysis (MATH 6461)

(4) Applied Algebra (MATH 6121)

(5) Algebra II (MATH 6122)

(6) Commutative Algebra (MATH 6130)

(7) General Topology (MATH 6540)

(8) Algebraic Topology (MATH 6550)

(9) Ordinary Differential Equations (MATH 6340)

(10) Partial Differential Equations (MATH 6350)

(11) Number Theory (MATH 6110 or MATH 6115)

(12) Probability Theory (MATH 6605)

(13) Category Theory (MATH 6180)

(14) Differential Geometry (MATH 6530)

(15) Set Theory (MATH 6040)

(16) Advanced Numerical Methods (MATH 6651)

(17) Numerical Solutions to Differential Equations (MATH 6652)

(18) Mathematical Modelling (MATH 6931)

(19) Mathematical Statistics (MATH 6620)

(20) Advanced Mathematical Statistics (MATH 6621)

(21) Generalized Linear Models (MATH 6622)

(22) Applied Statistics I (MATH 6630)

Note: While not all courses will be offered annually, course offerings will be responsive to students' need. Under special circumstances, exams may be taken in a year in which the course is not offered.

Pure mathematics students must complete at least one exam from (1) to (3), one exam from (4) to (6), one exam from (7) to (11), plus one additional exam which can be selected from any comprehensive exams listed above.

Applied mathematics students must complete exam (18), at least one exam from (9) or (10), at least one exam from (16) or (17), plus one additional exam which can be selected from any comprehensive exams listed above.

Statistics students must complete exams (19) to (22).

Note: For statistics students, (12) (Math 6605) is an acceptable substitute for the comprehensive exam (20) (Math 6621) whenever (20) (Math 6621) is not offered in the year.

Part-time students will have to complete the comprehensive exams by the end of their second year of enrolment.

Students are required to consult with the program director to make their course and exam selections. In certain extreme cases of difficulty due to scheduling, the PhD Committee will designate certain other courses as substitutes, arrange for reading courses, or modify the timing requirements. Students who are not enrolled in a course but elect to take a comprehensive exam should contact the instructor regarding the time and place of the exam. All comprehensive exams are submitted to the PhD Committee for evaluation.

The details of Policies and Procedures for Milestone Examinations in the PhD Program are available online.

Current master's students who plan to apply for admission to the PhD program may wish to take some of the comprehensive exams. The grades (PASS or FAIL) will be counted if the students are admitted to the PhD program.

Note: A student who fails any given comprehensive exam more than once, or fails more than a total of 3 comprehensive exams, will be withdrawn from the program.

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. MATH 6627 3.0 or an equivalent consulting course from another university, approved by the graduate program director, is required for all PhD students in Statistics. The course must be taken and passed within the first 6

semesters of the PhD program prior to Dissertation Subject Oral (see section below).

Dissertation Subject Oral

Students in the doctoral program must demonstrate depth of knowledge in their field of specialization. The candidate must pass an oral examination (Dissertation Subject Oral), which must occur before the end of 6th semester. In preparation for this examination, the student shall, in consultation with the supervisor and tentative supervisory committee, decide on a dissertation subject and a syllabus of materials. The syllabus of materials shall consist of those theoretical results, techniques, and examples in the area which are deemed most likely by the tentative supervisory committee to be useful in research on the dissertation subject.

The supervisory committee must approve the dissertation subject and agree that a command of the syllabus of materials will enable the student to pursue original research in that subject. A date for the examination will be set by the supervisory committee in consultation with the student.

The Dissertation Subject Oral shall consist of a 30-minute oral presentation of the dissertation subject and a question period, up to one hour in length. All members of the student's supervisory committee must be present. Members of the graduate program may attend the examination and may ask questions on the presentation or on the syllabus of materials. The Dissertation Subject Oral should be announced to the department and the syllabus made available to the supervisory committee members in advance. For more details related to Dissertation Subject Oral, please see Policies and Procedures for Milestone Examinations in the PhD Program.

At the end of the question period, the supervisory committee shall judge the examination as successful (Pass) or unsuccessful (Fail). In the latter case, the student may try again after additional study. If a student decides to change the dissertation subject, then an examination in the new subject will be required.

Thesis Proposal

Upon the successful completion of the examination of DSO, at the beginning of the thesis research, and no later than the end of the 9th term of study, students must submit a thesis proposal and ethics approval (TD-1). This is a summary of the proposed research, with bibliography, which should be reviewed by the supervisory committee before submission. The proposal and associated ethics approval are submitted via the FGS milestone portal, and the Graduate Program Assistant can support in the submission. This proposal is normally completed in the second year, immediately after the DSO, and students who do not complete this milestone by the end of the 9th term may face an enrolment block.

Dissertation Evaluation

The dissertation evaluation consists of two stages.

1) Dissertation Colloquium

Upon completion of work on the dissertation, the supervisory committee, in consultation with the student, will set a date (at least 25 working days prior to the oral exam) for a preliminary examination thereof (dissertation colloquium). The examination will consist of an oral presentation of the dissertation, of at most one hour duration, and a question period, up to one hour in length. Members of the graduate program in mathematics and statistics may attend the examination and may ask questions related to the student's dissertation. At the end of the question period the supervisory committee shall judge the examination. In the case of failure, a detailed rationale must be given to the student. This examination can be repeated, but only after an interval of at least one month. Supervisory committee members must be present during the repeat colloquium.

2) Dissertation Oral Examination

The dissertation will be defended in accordance with Faculty of Graduate Studies recommendations. An oral examination consisting of a 30 minute presentation followed by up to 2 hour question and answer period will take place, before a decision by the examining committee to pass thesis or not. See FGS guidelines on

examination of theses and dissertations for more details.

To schedule the oral exam, and approve the dissertation examining committee and external examiner, the student and supervisor (with the support of the Graduate Program Assistant) will submit a request for an oral exam via the FGS oral exam portal, no later than 30 business days before the intended exam date.

Faculty members and graduate students may attend the oral examination. They may, at the discretion of the chair of the examining committee, ask questions, but only members of the examining committee may be present for the evaluation and for the vote at the conclusion of the examination.

Progress Report

All students enrolled in a PhD program are required to complete an annual 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.

Supervisory Committees

Upon admission to the doctoral program, each student will be assigned a tentative supervisor from the graduate program. The student will decide on a study plan in consultation with the tentative supervisor, which will be confirmed during the first year of the program.

Dissertation Supervisory Committee

A student must choose a supervisor before the end of their 5th term. The supervisor must be submitted for approval by the graduate program director and the Faculty of Graduate Studies via the online FGS portal. The supervisor in collaboration with the student will appoint a supervisory committee by the end of their 6th term. This committee will be approved by the Graduate Program Director, and registered with Faculty of Graduate Studies, via the online FGS portal.

Academic Standing

Students who receive a grade of C in three 3-credit courses, or one C and one F, will be deemed by Faculty of Graduate Studies to have fallen out of good academic standing, and face withdrawal from the program.

Important Notes

Full-time doctoral students must register and pay fees for a minimum of 6 terms. Part-time doctoral students must register and pay fees for a minimum of 12 terms. Part-time students are not eligible for funding.

Students who successfully complete a master's or PhD program in less time than the program length, will, prior to convocation be responsible for payment of a balance of degree fee. For the calculation of balance of fees, one full term is equivalent to two part-time terms.

Also note: because of stipulations in the TA contract, it can happen that not enough of the funding package is deposited into your student account, and too much is deposited in your bank account, leading to an amount owing on your student account. The total funding is paid out, but as you can imagine it is an unpleasant surprise for students who find out that not all of their fees were paid automatically. Please check your student account regularly, to make sure that there is no amount owing.

Key timelines in the PhD program

- Petition for credit transfer (if not used for obtaining another degree): must be within the first semester
- Comprehensive exams: must be completed within the first 3 semesters
- Supervisor: must be recommended and approved before the end of 5th semester
- Supervisory committee: must be recommended and approved before the end of 6th semester
- Dissertation Subject Oral: must be completed before the end of 6th semester
- Thesis proposal and TD1: must be completed before the end of the 9th semester
- Colloquium: must be within the semester of Dissertation Oral Examination, and at least 25 working days prior to the oral examination

Financial Support

Most full-time students are offered some financial support in the form of a teaching assistantship (TA) and/or a research assistantship (RA). Full-time MA students who are offered financial support will receive this support in year one of full-time studies. Full-time MSc students who are offered financial support will receive this support in year one and year two of full-time studies. Full-time PhD students who are offered financial support will continue to receive this support for four years provided their studies are proceeding in a satisfactory manner.

In addition to York support, students are urged to seek financial support from external sources. Part-time students are not eligible for financial support from York.

External Scholarships

Students with high averages are strongly encouraged to apply for external scholarships. These include NSERC and OGS scholarships. For NSERC scholarships, the student must be a citizen or permanent residence of Canada. The OGS is open to all students, including international (visa) students. Starting Fall 2025, some NSERC PhD scholarships may be made available to PhD students.

York Graduate Scholarships

A limited number of entrance scholarships are awarded to outstanding full-time students. These are valid for the first year of study only at the master's or doctoral level and are not renewable.

York Recruitments Awards

A limited number of recruitment awards may be available for outstanding full-time students. These awards are intended to bring high calibre students to the graduate program at York; they are valid for the first year of MA, MSc, and PhD programs only and are not renewable.

Bursaries

Full-time registered graduate students who are paying full-time fees and have financial need may apply to the Faculty of Graduate Studies for a bursary.

Type of Support at Admission

Type of Support	Degree Program		
	MA	MSc	PhD
TA	1/year	1/year	1/year
TA top-up to	—	—	—
RA	—	Yes	Yes
YGF	Yes	Yes	Yes
YGS	Limited (requires minimum A GPA)		
Recruitment Award	Limited (requires minimum A GPA)		

Intellectual Property Policy

The Faculty of Graduate Studies recognizes the mission of the university to seek, preserve, and disseminate knowledge and to conduct research in a fair, open, and morally responsible manner.

In such regard, the Faculty of Graduate Studies believes that intellectual property rights are divided among several interests, and that the rights and obligations of various claimants should be specified, fairly regulated, and that disputes arising may be mediated. All parties students and faculty are expected to behave in an ethically appropriate manner beyond their immediate graduate student/supervisory relationship, to encompass intellectual property rights, dissemination of research data, and in making decisions on authorship and publication of joint research.

Because of the varied cultural aspects and practices that differ among the graduate programs, each program is responsible for enacting and enforcing this policy of appropriate ethical practices on intellectual property rights, in compliance with the Faculty Policy on Intellectual Property for Graduate Programs. Programs which choose not to enact their own specific policy are bound by the Faculty Policy on Intellectual Property for Graduate Programs, which can be found online.

Application of the Faculty of Graduate Studies Intellectual Property Policy

The purpose of this section is to allow programs to enact a variant policy, to take into account normative practices and procedures of a discipline that may not be adequately described in the Faculty Policy on Intellectual Property for Graduate Programs. Programs will have an obligation to inform their students and faculty of the existence of the program policy, and especially of the nature of any special conditions, or of the Faculty Policy on Intellectual Property for Graduate Programs, if a program does not elect to formulate their own policy.

In the production of a program policy, no program may impose unreasonable or unusual conditions on any student or faculty member as a condition of admission to, or participation or teaching in a program. Furthermore, no individual agreement between a faculty member and a graduate student will impose unreasonable or unusual conditions on the student.

To ensure that the unequal power and influence of the faculty member in the supervisor/student relationship does not overwhelm the student, the Executive Committee of the graduate program will review all individual agreements to ensure that this condition is respected. The policy of each program must ensure that the Executive Committee of the Graduate Program may annul any individual agreement, and/or ask for redrafting of an agreement, where they consider that this condition has not been respected.

The program policy will be entitled 'Intellectual Property Policy of the Graduate Program in Mathematics and Statistics', and must be submitted to the Faculty of Graduate Studies for approval by the Executive Committee and Council within three months after approval of the Faculty Policy on Intellectual Property for Graduate Programs.

The Faculty Policy for Graduate Programs on Intellectual Property Relationships between Graduate Students and Their Supervisors

The following clauses, concerning authorship, publication and individual agreements, relating to graduate students and their supervisors, are to serve as the Faculty Policy on Intellectual Property for Graduate Programs who wish to devise their own policy, principles and practices. Clauses 1 through 15, either in their entirety or reworded, must be included in all graduate programs'

policies. If clauses are reworded, the programs must ensure that the spirit of the Faculty wording is encompassed. The clauses may be augmented if the programs so wish. All program policies, which will be expected to have an appropriate preamble, are subject to the approval of the Faculty of Graduate Studies Executive Committee and Council.

Authorship

- Authorship can only be credited to those who make substantial intellectual contributions to a piece of work. Accepting the addition of an author who has not made a significant intellectual contribution to the piece of work is not ethical for authors.
- Authors accept not only credit but also responsibility for their work and, in particular, for ensuring that the work conforms to appropriate standards of Academic Honesty.
- Generally, the order of authors' names in a publication should reflect the substance of their relative contributions to the work, with priority going to those who made the greatest or most significant contribution. Supervisors should discuss the issue of authorship, and what factors may determine the final order of authorship, normally before commencing the work.
- Where the major substance or data of a co-authored publication is based on a portion of a graduate student's work, the student will normally be the first author. The supervisor, or joint authors should be prepared to offer a rationale in cases where the student is not listed as the first author. Where the work has been written up in a dissertation or thesis or paper before the research is published, the publication will normally cite the dissertation, thesis, or paper on which it is based.
- Anyone otherwise entitled to be acknowledged as a co-author may forfeit that right if they leave the project before substantially completing it. In such cases their contribution to the work shall nonetheless be acknowledged in an appropriate manner by the author(s), for example in the acknowledgements section of the publication.
- Providing financial support for a student's dissertation, thesis, or research paper is not, in itself, sufficient to warrant authorship. Only where intellectual input is provided beyond financial support, should co-authorship be considered.
- Supplying minor editorial work for a student's dissertation, thesis, or research paper is not, in itself, sufficient to warrant co-authorship.
- If a student is employed as a Research Assistant in circumstances where the work done in the course of that employment is not intended to and does not in fact become part of work done for the degree requirements, then the student may not normally claim co-authorship and does not own the data, except through a prior agreement that is consistent with the general principles above.
- If a student is employed as a Research Assistant in circumstances where the work done in the course of that employment becomes part of the thesis/dissertation/research paper, the student may, at a minimum, claim co-ownership of the data but as the author of the thesis/ dissertation/research paper owns the overall copyright.

Publication

- The university has an important duty, grounded in the public interest, to seek, preserve and disseminate knowledge. Therefore, authors should attempt to publish their work in a timely fashion. In cases where work must be kept confidential and unpublished for a time, the period of delay should normally be no more than one year from the date of acceptance of a thesis or dissertation, and should in no circumstances extend beyond two years from that date.
- Publications by graduate students and faculty must give full and proper acknowledgment to the contribution of other students or faculty, or others to their work, notwithstanding that

such contribution may not warrant authorship. Such contributions should be substantial, in accordance with the particular discipline, and may include items such as original ideas that led directly to the research work, or requested commentary that resulted in significant changes to the research.

- Normally, all co-authors or co-owners of the data need to concur in publishing or presenting the work. Co-authors should agree to the time or place of presentation or publication of their jointly authored work prior to the presentation or publication, but such agreement should not be unreasonably withheld. The inability of the author(s) to contact another co-author prior to presentation at a meeting or seminar should not prevent work from being publicly disseminated, provided they make reasonable efforts to contact all contributors to obtain prior agreement.
- To verify research materials or data, there must be provisions for access. Supervisors and sponsors may, with agreement of the student, retain the original materials provided. Under such circumstances students shall normally be presented on request with complete and usable copies of those materials.
- Where there has been significant substantive and intellectual contribution by the supervisor to the research, the intellectual property emanating thereof shall normally be the joint property of graduate students and their supervisor or sponsor for the masters or doctoral project in which the materials were created. When the physical research materials embody intellectual property, the student should have reasonable access to this material. Agreements concerning research materials and data should be made, where possible, before the commencement of research.
- Students shall not use in their dissertations, theses or papers data or results generated by someone else without first obtaining permission from those who own the materials.

Individual agreements

- Students and faculty may enter into individual agreements that modify their intellectual property rights. If they do so, the provisions of clauses below must be observed.
- Individual agreements should specify any financial relations and associated rights and obligations, provisions for ownership and control of original data and research materials, authorship, publication, and presentation.
- All individual agreements must explicitly state that they are subject to applicable Collective Agreements and all University regulations in force at the time.
- All individual agreements must be completed within four months of a student starting a significant portion of the research for a thesis or dissertation, or within four months of the student joining a laboratory. In the case for students joining a specific laboratory to undertake research with a specific supervisor, the supervisor should indicate prior to the arrival of the student the nature of any agreement expected to be entered into between the supervisor and the student.
- All individual agreements will be reviewed by the Executive Committee of the graduate program to ensure that the agreement does not impose any unreasonable or unusual conditions on the student. The Executive Committee of the graduate program may annul any individual agreement or ask for redrafting where this condition has not been respected.

Education and Information

Education is a most powerful tool to promote appropriate ethical behaviour in the graduate student/supervisor relationship, especially concerning intellectual property rights, dissemination of research data, authorship, and publication of joint research. Moreover, a suitable educational session to inform graduate students of their rights and obligations concerning intellectual property and associated aspects would go a long

way to ensuring that potential conflicts are eliminated before intervention is required. Therefore, graduate programs should present an educational and information session to incoming graduate students on such matters as part of their orientation. To assist in this task, graduate programs should use the section of the report of the Task Force on Intellectual Property entitled "Intellectual Property and the Graduate Student at York", and ensure that copies of this section are provided to all new faculty and incoming graduate students. Furthermore, the graduate programs would find an educational session useful to continually update faculty members on what documentation may or should be included in appropriate individual agreements. To ensure that the educational session is held, graduate programs are required to include in their intellectual property policy the following statement:

That graduate program in Mathematics and Statistics will normally hold an information session on ethical aspects of research including intellectual property rights, and related issues, during the orientation session for new incoming graduate students. All new students and faculty will be provided with copies of the most recent edition of the document entitled "Intellectual Property and the Graduate Student at York."

Dispute Resolution

In such a complex area, disputes may arise even among people of good will, for example, out of conflicting understandings of fact, or interpretations of the law, faculty or program regulations, or individual agreements.

The primary role of the Faculty of Graduate Studies should be to provide general directives and principles governing the graduate student/supervisory relationship, to educate and inform parties about their rights and appropriate behaviour, and to assist parties in mediating disputes. The latter imply that the parties can probably come to a voluntary and informed agreement between themselves. Generally, the imposition of resolutions by a Faculty or by arbitrators is far less satisfactory. Therefore, the following mediative process is suggested as a means of resolving disputes.

In disputes arising out of Program Policies or Individual Agreements, parties should initiate a complaint in writing, and bring it to the attention of the program director of the program in which the student is enrolled, with a copy to the Dean of the Faculty of Graduate Studies.

The program director should arrange an informal meeting of the parties to discuss the substance of the dispute, the possibility of negotiating an agreement at the program level, and to determine the necessity of approaching the Faculty for assistance. At the meeting, the parties shall be informed that they may at their own expense, seek legal remedy. At any point, if any party chooses to proceed in law, the mediative role of the program or faculty shall end.

If the parties choose to proceed to mediation, a mediator acceptable to the parties, preferably from outside the graduate program will be used, unless all parties agree to mediation by the Program Director. In cases where the nature of the dispute involves a requirement for technical knowledge of the matter, the Program Director may form a hearing committee consisting of herself/himself and necessary experts in the subject matter who preferably come from outside the graduate program. In assisting the parties in mediation, the program director or mediator must have regard to the fact that students and faculty generally stand in a relation of unequal power, and thus ensure that any agreement reached is consistent with the general principles of the report of the Task Force on intellectual Property.

If the dispute cannot be settled by mediation within the program, and on request of the parties, the Dean of the Faculty of Graduate Studies or his or her representative shall review the initial attempt at mediation, and if warranted may proceed with a new attempt at mediation, subject to the same conditions as stated above. In matters outside of ownership of intellectual property, the Faculty may direct how a settlement should be reached.

Course Outlines S2026, F2026, W2027

MATH 6004 0.0 S/F/W
Seminar

This course provides students with a chance to work independently and to present the results of their work to other students. Each student gives two one-hour seminars on topics arranged with two different faculty members. The topics may be related to other courses the student is taking, but should not be covered in those courses. They may be in the same field or two different fields. Students are expected to submit a written report prior to presenting each seminar. The seminars are graded separately and the course is graded on a pass/fail basis. Students in the course are expected to attend all seminars.

Main Source
Determined by the supervisor.

Course Director
Supervisors, one per seminar.

MATH 6121 3.0 F2026
Applied Algebra

This course covers topics that generally appear in any first graduate algebra course, but are likely to be used in many applications (usually to other areas of mathematics). Topics include advanced linear algebra, group theory and group representations, commutative rings and fields, and computational algebraic geometry.

Main Sources
TBD

Course Director
Mohamed Omar, Ross S621

MATH 6122 3.0 W2027
Algebra II

Further ring and module theory; more on ideals (primes, irreducible, maximal, etc), UFD, injective and projective modules;

Fields theory and Galois theorems: field extensions, splitting fields, automorphism group of fields, Galois correspondence, Galois groups of polynomials, solving polynomials with radicals;

Introduction to category theory. Introduction to algebraic geometry: varieties, radical ideals, Hilbert's nullstellensatz.

Main Source
Algebra", T. W. Hungerford, GTM Springer.
Abstract Algebra", D. S. Dummit and R. M. Foote, Willey.
"An Introduction to Computational Algebraic Geometry and Commutative Algebra", D. A. Cox, J. Little and D. O'shea, UTM Springer.

Course Director
Nantel Bergeron, DB 2029

MATH 6280 3.0 W2027
Measure Theory

A measure on a collection of subsets (or events) of a set is a function with certain desirable properties that describes the size (or probability) of each element of the collection. Given a measure it is possible to define an integral of specific functions against the measure thereby generalizing the Riemann integral. Both measures and this integration theory are essential concepts in probability theory and functional analysis.

In this course, we will begin by defining the notion of a measure and developing methods for constructing measures. Subsequently, we will study specific functions, known as measurable functions, and prove results such as Lusin's Theorem and Egorff's Theorem. Measurable functions will permit an integration theory and the study of many additional topics, such as Fatou's Lemma, the Dominated Convergence Theorem, Fubini's Theorem, Hahn and Jordan decompositions, the Lebesgue Differentiation Theorem, the Fundamental Theorems of Calculus, the Radon-Nikodym Theorem, the Lebesgue Decomposition Theorem, and Lp-spaces.

Main Source
Lecture notes will be provided.

Real Analysis, by Royden and Fitzpatrick, 4th edition (optional).

Course Director
Paul Skoufranis, Ross S625

MATH 6300 3.0 S2026
Complex Analysis

This is a first graduate course in complex analysis. The prerequisite is an undergraduate course in mathematical analysis up to and including uniform convergence and its basic properties. A working knowledge of complex numbers is assumed. Students are expected that by the completion of the course to understand the concepts of and solve problems on holomorphic functions, Cauchy-Riemann equations, Cauchy's integral formula, maximum modulus principle, power series and Laurent series, zeros and singularities, the calculus of residues, biholomorphisms (conformal mappings), fractional linear transformations, Schwarz 'lemma, automorphism groups of the unit disk and the upper half plane, SU(1,1) and SL(2,R), and the Schwarz problem on the unit disk.

Main Source
M. W. Wong, Complex Analysis, World Scientific, 2008

Course Director
Man Wah Wong, Ross N626

MATH 6340 3.0 W2027
Ordinary Differential Equations

This graduate course develops the modern theory of ordinary differential equations and dynamical systems. Topics include existence and uniqueness, continuous dependence, linear systems and stability, Floquet theory, local analysis of nonlinear systems, Lyapunov stability, limit sets and attractors, linearization and invariant manifolds, the Hartman–Grobman theorem, planar systems and the Poincaré–Bendixson theorem, phase-plane methods, periodic orbits and Poincaré maps, limit cycles, normal forms and bifurcation theory. Applications in biology, physics and finance.

Main Source
Lawrence Perko, Differential Equations and Dynamical Systems, 3rd Edition, Springer.

Lecture notes of selected topics will be provided.

Course Director
Huaiping Zhu, Ross N618

MATH 6350 3.0 F2026
Partial Differential Equations

This is a basic course in Partial Differential Equations based on Pseudo-Differential Operators on the Euclidean space. We begin the course with Fourier analysis and tempered distributions. Then we introduce pseudo-differential operators with a symbolic calculus. Approximate solutions of partial differential equations modelled by elliptic pseudo-differential operators are constructed and the global regularity of solutions in terms of Sobolev spaces are studied.

The main prerequisite for the course is a course in Real Analysis with Lebesgue integrals.

Main Sources

M. W. Wong, An Introduction to Pseudo-Differential Operators, Third Edition, World Scientific, 2014

Course Director
Man Wah Wong, Ross N626

MATH 6373 3.0 S2026
Computational Dynamical Systems

This course will introduce basic concepts and techniques of bifurcation theory for discrete and continuous dynamical systems. These include topological equivalence and structural stability of dynamical systems, local bifurcations of equilibria and periodic orbits, normal forms, and global bifurcations. Most of the computational tasks in the course can be carried out with MATLAB and MAPLE. The goal of this course will be to introduce the computational skills and tools to compute the behavior of differential equations as parameters varies, to explore the bifurcations and complex dynamics. Dynamical models in biology will be explored as examples.

Main Source
TT Yuri Kuznetsov, Elements of Applied Bifurcation Theory, Springer-Verlag.
Lawrence Perko, Equations and Dynamical Systems. Springer.
Lecture notes of selected topics will be provided.

Course Director
Huaiping Zhu, Ross N618

MATH 6461 3.0 F2026
Functional Analysis I

In this course, linear algebra finally meets calculus, and this happens in an infinite-dimensional space. Functional analysis is the study of topological vector spaces over the real and complex fields. A deeper understanding of such spaces is obtained by study of continuous linear operators between them.

We will cover the following topics.

Topological vector spaces. Normed spaces, Banach spaces.
Baire Category Theorem and its consequences.
Classical Banach spaces, Hilbert space.
Local convexity, Hahn--Banach theorems.
Weak topologies, compactness, dual spaces, Banach-Alaoglu theorem.
Convexity, Krein-Milman theorem.
Stone-Weierstrass theorem.

Time permitting, we will cover selected topics on bounded linear operators on Hilbert space and spectral theorem for compact operators.

Main Source
J.B. Conway, A course in functional analysis.
G.K. Pedersen, Analysis Now.
W. Rudin, Functional Analysis.
C.D. Aliprantis, K. Border, Infinite-Dimensional Analysis: A Hitchhiker's Guide.
I. Farah, Lecture notes

Course Director
Ilijas Farah, Ross N517

MATH 6540 3.0 F2026
Topology I

A topological space is a set along with a collection of subsets that formalize a notion of a nearness between points and subsets. Topology provides a framework to study continuity in the broadest setting applicable across many areas of mathematics, especially Functional Analysis. We will begin from the basic fundamental concepts and then focus on compact spaces, metrization, separation axioms, connectedness, product spaces, convergence, and other topics.

Main Source
Munkres, James R.; Topology, second edition. Prentice Hall (2000)

Willard, S.; General Topology, Dover.

Course Director
Paul Szeptycki, Ross N634

MATH 6602/4430 3.0 F2026
Stochastic Processes

This course introduces the fundamentals of stochastic processes, with a primary focus on discrete-time Markov chains and continuous-time Markov chains, including several important special cases. Time permitting, we will also explore Brownian motion and its applications. The course begins with a review of probability theory, covering essential topics such as discrete and continuous random variables, and conditional expectations. By the end of the course, students are expected to develop the analytical tools needed to model, interpret, and apply the stochastic processes covered, preparing them to apply the concepts to the relevant fields.

Main Source
Lawler, Gregory F., Introduction to Stochastic Processes, Chapman & Hall/CRC, 2006.

Lecture notes will be provided.

Course Director
Dongchen Li, DB 2028

MATH 6605 3.0 W2027
Probability Theory

This course examines the essentials of probability theory from the rigorous mathematical viewpoint. Topics include basic measure theory, the weak and strong laws of large numbers, the Borel-Cantelli lemma, zero-one laws, the law of the iterated logarithm, convergence in probability and weak convergence, characteristic functions, the central limit theorem, conditional probability and expectation, and martingales.

Prerequisite: An undergraduate course in probability. An introductory analysis course is not formally required, but students will benefit from previously having worked with rigorous limits of sequences.

Main Source
Jeffrey Rosenthal, A First Look at Rigorous Probability Theory, 2nd edition. World Scientific, 2006.

Course Director
Neal Madras, Ross S616

MATH 6620 3.0 F2026
Mathematical Statistics

This course serves as a graduate level look at foundations of mathematical statistics. The topics include fundamentals of statistical inference, various methods of estimation, and principles of hypothesis testing. Special topics will be added if time permits.

Main Source
Statistical Inference by Casella & Berger (2nd edition)
Mathematical Statistics by Jun Shao (2nd edition)
Mathematical Statistics by Keith Knight.

Course Director
Hanna Jankowski, DB 2038

MATH 6621 3.0 W2027
Advanced Mathematical Statistics

This course will cover a broad range of limit theorems useful in mathematical statistics, along with methods of proof and techniques of application. It will begin with a variety of tools and foundations basic to asymptotic theory in statistics. Then, the asymptotic properties of the following statistics are considered: (a) The usual statistics computed from a sample; (b) The statistics concocted as transformations of vectors of more basic statistics; (c) statistics arising in classical parametric inference and contingency table analysis; (d) U-statistics. As time and interest permit, further related topics may also be covered.

Main Source
Text: Mathematical Statistics, 2nd edition by Shao, J., 2003, Publisher: Springer

Course Director
Yuehua Wu, DB 2036

MATH 6622 3.0 W2027
Generalized Linear Models

Generalized Linear Models (GLMs) are an extension to linear models where the response variable is not continuous. These models are commonly used for analysis where the response variables are binary, categorical, proportions, or counts. GLMs play a crucial role in statistics and can be widely applied in industry, government, and banks as well as other areas. Tentative topics will include: review of linear models; formulation of GLMs; link functions; iterative least squares algorithms; deviance and asymptotic theory; model selection; residuals and quasi-likelihood; generalized linear mixed models.

Main Source
An Introduction to Generalized Linear Models by Annette J. Dobson and Adrian G. Barnett, 4th Edition, CRC Press.

Course Director
Tianyu Guan, Ross N621A

MATH 6627 3.0 W2027
Practicum in Statistical Consulting

The objective of Math 6627 - statistical consulting practicum is to help students develop skills required for statistical consulting. Students will develop their practical data analysis skills, communication skills, and practical aspects of various statistical topics. Students will learn strategies for presenting

statistical findings verbally and in written format. Students will learn strategies for working cooperatively with other researchers and institutions. We will also cover common statistical modeling techniques that arise in consulting, such as mixed models. The course provides hands-on training in statistical consulting.

Main Source
Lecture Notes are provided.

Course Director
Kelly Ramsay, Ross S511A

MATH 6630 3.0 F2026
Applied Statistics I

The course will include the following topics in applied statistics: Maximum likelihood estimation using numeric methods including continuous and discrete; Optimization; Methods for missing data including the EM algorithm; Monte Carlo simulation methods; Markov Chain Monte Carlo methods; Bootstrap and Jackknife methods.

Main Source
G. Givens and J. Hoeting (2013) Computational Statistics, 2nd ed., Wiley (Chapters 1-4, 6, 7, 9).

Course Director
Xin Gao, Ross N623

MATH 6632/4630 3.0 W2027
Multivariate Statistics

The primary aim is the interpretation of such data, beginning with the multivariate normal distribution and proceeding to standard multivariate inference theory. Sufficient theoretical background will be developed to facilitate an understanding of the core concepts, which will require a solid foundation in matrix algebra and some familiarity with vector spaces. SAS and R will be used for implementation. Topics covered include the multivariate normal distribution; inference about means and linear models; principal component analysis; canonical correlation analysis; and an overview of discriminant analysis, factor analysis, and cluster analysis. Several of these topics form the essential theoretical foundation for modern big data analysis.

Main Source
TBD

Course Director
Augustine Wong, DB 2041

MATH 6633/4331 3.0 F2026
Time Series Analysis

This course introduced the theory and practice of time series analysis, focusing on modeling and forecasting temporally dependent data. We studied stationarity, autocovariance and autocorrelation, and classical linear models including AR, MA, and ARMA processes, with emphasis on causality and invertibility. Model identification using ACF and PACF was developed alongside the theory of optimal linear prediction based on both finite and infinite pasts. Recursive algorithms such as the Durbin–Levinson and innovation algorithms were used to construct forecasts and prediction error variances efficiently. The course concluded with multi-step forecasting, interpretation of mean squared prediction errors, and practical smoothing methods including exponential smoothing, Holt's method, and Holt–Winters forecasting.

Main Source
R.H. Shumway, S.D. Stoffer, Time Series Analysis and Its Applications With R Examples, 4th edition, Springer.

Course Director
Kaiqiong Zhao, Ross S514

MATH 6635 3.0 S2026
Introduction to Bayesian Statistics

Bayesian inference is one of the major philosophies of inference in statistics. Until recent advances in computation, particularly in MCMC, Bayesian methods were difficult to apply to any but relatively simple problems. Now, Bayesian methods provide solutions for inference involving complex data structures that are otherwise difficult to tackle. This has made an understanding of Bayesian methods important for applied statisticians regardless of philosophical inclinations.

This course will explore the history and the philosophical foundations of Bayesian inference, contrasting its rationale with that of other major approaches: the dominant frequentist approach as well as fiducial and structural approaches that offer a degree of resolution.

Most of the course will be devoted to learning applied Bayesian methods culminating in the use of Hamiltonian Monte Carlo for generalized mixed effects models. We will use a number of R packages for Bayesian analysis including 'rstan'.

Main Source
Gelman, A., Carlin, J. B. et al. (2013) Bayesian Data Analysis, 3rd edition. CRC Press.

Course Director
Georges Monette, DB 2042

MATH 6644 3.0 W2027
Statistical Learning

This course introduces the theory and practice of statistical learning with an emphasis on prediction, model assessment, and modern supervised/unsupervised methods. Topics include linear models, regularization (ridge/lasso), dimension reduction, tree-based methods, ensembles, support vector machines, neural networks, and clustering. Students learn how to select and evaluate models using resampling (cross-validation, bootstrap) and how to communicate results with clear, reproducible workflows using Python. A course project applies statistical learning methods to a real dataset.

Main Source
Selected readings and instructor-provided notes. James, Gareth, et al. "An introduction to statistical learning: With applications in Python." Cham: Springer International Publishing, 2023.

Course Director
Divya Sharma, Ross N636

MATH 6650 3.0 F2026
Introduction to Statistical Data Science

This course provides a general introduction to Data Science. It gives an answer to "What is Data Science" and "What is/isn't a Data Science project". We will go through the main steps of a Data Science project explaining the theoretical and/or practical aspects, by using different Statistical and technological tools. It gives a general idea of data exploration, statistical analysis, machine learning, data visualization, among other steps present in the Data Science cycle. The main part of the course is in Python. Students (in groups) will deliver a data science project as a result of their learning.

Main Source
Lecture notes will be provided

Course Director
Jairo Diaz-Rodriguez, Ross N637

MATH 6651/4141 3.0 F2026
Advanced Numerical Methods

Topics in this course include: Numerical methods for solving ordinary differential equations including initial-value problems and boundary-value problems; Optimization problems: Golden method, simplex method, steepest descents, conjugate gradient methods including nonlinear conjugate gradient methods; Approximation theory: least squares, orthogonal polynomials, Chebyshev approximation, Fourier approximation and Fast Fourier Transforms, and Pade approximation.

Main Source
Lecture notes will be provided

Course Director
Dong Liang, Petrie 225

MATH 6652 3.0 W2027
Numerical Solutions to Differential Equations

This course will include: an introduction to the MATLAB programming language with application to numerical integration and linear algebra; an overview of numerical methods for solving initial and boundary value problems of ordinary differential equations, including Runge-Kutta methods and their application to dynamical systems; finite difference approximations of derivatives; the numerical solution of canonical partial differential equations: a) parabolic equations, including the Crank-Nicholson and

Alternating Direction Implicit methods; b) hyperbolic equations, including a discussion of dispersive versus dissipative errors; c) elliptic equations, including iterative methods such as successive over-relaxations. The convergence and stability of solution methods will be discussed throughout.

Main Source
Lecture notes will be provided.

Morton, K.W. and Mayers, D.F. Numerical Solution of Partial Differential Equations, Cambridge University Press.

LeVeque, R.J. Finite Difference Methods for Ordinary and Partial Differential Equations, SIAM

Epperson, J.F. An Introduction to Numerical Methods and Analysis, Wiley.

Course Director
Miles Couchman, Ross N617

MATH 6910 3.0 F2026
Stochastic Calculus in Finance

This course aims to equip students with a solid foundation in the stochastic calculus underlying the pricing and hedging of derivative instruments. We begin with the binomial tree pricing model, exploring fundamental concepts such as arbitrage and risk-neutral pricing in a discrete-time framework. The course then moves to advanced continuous-time models, delving into key mathematical concepts, including martingales, Brownian motion, Itô's integral, and Itô's formula, as applied in the Black-Scholes option pricing model. Additionally, we will study exponential martingales and Girsanov theorem in the context of risk-neutral measures.

Topics include:

Binomial pricing model

General probability theory

Information and conditioning

Brownian motion

Stochastic calculus

Risk-neutral pricing

Interest-rate models (time permitting)

Main Source
S. Shreve, Stochastic Calculus for Finance II: Continuous Time Models, Springer 2010

Course Director
Jingyi Cao, DB 2031

MATH 6912 3.0 W2027
Machine Learning in Finance

Machine learning (ML), a branch of artificial intelligence, is the science of programming computers to improve their performance by learning from data. Dramatic progress has been made in the last decade, driving machine learning into the integration of our daily life, technology, business services and finance. This course views the technical elements of machine learning, provides fundamental understanding of various machine learning models and algorithms, and explores their application in finance industry.

Students will learn how to implement commonly used ML algorithms in Python programming.

Main Source
John C. Hull, Machine Learning in Business: An Introduction to the World of Data Science, Independently published (May 26 2021), 979-8508489441
Programming language: PYTHON

Course Director
Hongmei Zhu, Petrie

MATH 6914 3.0 S2027
Data Driven Finance in Python

This graduate course prepares students for today's data-driven finance industry, where the volume and velocity of financial data are the foundation of trading, pricing, forecasting, and risk management. Python is the choice of programming language in this course as it has just emerged as one of the major strategic technology platforms. The course will start with an immerse introduction of Python at a fast speed suitable for graduate students and will spend majority of time on financial data: how to use Python to access, process, analyze, and utilize financial data offline and online.

Main Source
Python for Finance: mastering data-driven finance, by Yves Hilpisch, O'Reilly Media Inc., 2nd edition.

Course Director
Michael Chen, DB 2034

MATH 6931 3.0 F2026
Mathematical Modelling

This course extends the principles and practices of mathematical modelling for real-world systems in natural sciences and other fields. You will learn a variety of mathematical modeling approaches with applications in chemistry, biology, economics, social science, medicine, etc., with case studies (population models of growth, interacting species, epidemics, pathogen-host interactions, evolution); coding and computational experiments (simulating stochastic and deterministic methods using Python or your own choice of programming language). Emphasis will be placed on model development, analysis, simulation, and communication of findings. Specifically, principles of modelling (concepts, types of modelling, formulation, conservation principle, compartmentalization); Theory of dynamical systems (continuous and discrete models; stability analysis, bifurcations, simulation methods, and phase illustrations), etc. Our Modeling approach uses ODEs, discrete equations, Delay DEs, PDEs, stochastic, and, where time permits, an introduction to PINNs will be covered.

Main Source
Lecture notes will be provided.
Serovajsky, Simon. "Mathematical modelling". Chapman and Hall/CRC, 2021.
Allen Linda J. S., "An Introduction to Mathematical Biology", 2007.
Giordano, F. R., Weir, M. D., & Fox, W. P. (1985). A first course in mathematical modeling.
Moghadas SM, Jaberi-Douraki M, "Mathematical Modelling: A Graduate Textbook", Wiley. 2018.

Course Director
Woldegebriel Assefa Woldegerima, Ross S614

MATH 6936 3.0 W2027
Mathematical Epidemiology

The mathematical modeling of infectious diseases is studied on two different scales: between individuals in a population (epidemiology) and within an infected individual (immunology). The objective of this course is to present a detailed introduction to the mathematical modeling of the infectious disease in both epidemiological and immunological contexts. Topics include: immune system components (i.e. T-cell activation, clearance of infection, etc), pathogen characteristics (i.e. HIV, influenza, etc), intervention strategies (i.e. drug therapy and vaccination) and model development (i.e. continuous and discrete time models, computer simulations, stochastic and deterministic model, etc). The fundamental predictors of infection, the basic reproductive ratio and initial growth rate will be introduced. Relationships between immunological characteristics and epidemiological effects, such as disease transmission and acquirement of immunity, are also discussed.

Main Source
TBD

Course Director
Jane Heffernan, Ross N615

MATH 6937 3.0 S2026
Practicum in Industrial and Applied Mathematics

This practicum course will be based on interdisciplinary and real-life application problems. Each time, a problem will be presented to students in class. The students are required to use the methods they have been learning from Math 6931 (Mathematical Modeling) to derive a reasonable mathematical model, to analyze and solve the model both analytically and numerically. Students will be encouraged to work in groups. Evaluation will be based on individual reports and group presentations.

Main Source
Lecture notes will be provided

Course Director
Jianhong Wu, Ross S519

MATH 6940/4940 3.0 F2026
Perturbation Methods

This course will explore how to find approximate solutions to problems that do not have closed analytic forms which is an excellent complement to mathematical modelling and numerical methods. This course first introduces perturbative methods as a tool for finding solutions to polynomial and non-linear equations. It then applies perturbation methods in areas such as eigenvalue approximations, approximating integrals, and solutions to differential equations.

Main Source

Hinch, Perturbation Methods

Bender and Orszag, Advanced Mathematical Methods for Scientists and Engineers

Lecture notes will also be provided

Course Director

Iain Moyles, Ross S519

List of Graduate Courses S2026, F2026, W2027

Summer 2026			
MATH 6300	Complex Analysis	S1, MTRF 14:00-15:30	Man Wah Wong
MATH 6373	Computational Dynamical Systems	S1, Tue-Thu 10:30-13:30	Huaiping Zhu
MATH 6635	Introduction to Bayesian Statistics	S1, Tue-Thu 13:00-16:00	Georges Monette
MATH 6937	Practicum in Industrial & Applied Mathematics	S2, Tue-Thu 13:30-16:30	Jianhong Wu

Fall 2026			
MATH 6121	Applied Algebra	Tue-Thu 10:00-11:30	Mohamed Omar
MATH 6350	Partial Differential Equations	Tue-Thu 11:30-13:00	Man Wah Wong
MATH 6461	Functional Analysis I	Tue-Thu 13:00-14:30	Ilijas Farah
MATH 6540	Topology I	Mon-Wed 13:00-14:30	Paul Szeptycki
MATH 6602/4430	Stochastic Processes	Wed-Fri 11:30-13:00	Dongchen Li
MATH 6620	Mathematical Statistics	Tue-Thu 10:00-11:30	Hanna Jankowski
MATH 6630	Applied Statistics I	Tue-Thu 14:30-16:00	Yi Liu
MATH 6633/4331	Theory and Methods of Time Series Analysis	Tue-Thu 13:00-14:30	Kaiqiong Zhao
MATH 6650	Introduction to Statistical Data Science	Mod-Wed 16:00-17:30	Jairo Diaz-Rodriguez
MATH 6651/4141	Advanced Numerical Methods	Tue-Thu 14:30-16:00	Dong Liang
MATH 6910	Stochastic Calculus in Finance	Fri 14:30-17:30	Jingyi Cao
MATH 6931	Mathematical Modelling	Mon-Wed 13:00-14:30	Woldegebriel Assefa Woldegerima
MATH 6940/4940	Perturbation Method	Mon-Wed 11:00-12:30	Iain Moyles

Winter 2027			
MATH 6122	Algebra II	Tue-Thu 10:00-11:30	Nantel Bergeron
MATH 6280	Measure Theory	Tue-Thu 14:30-16:00	Pavlos Motakis
MATH 6340	Ordinary Differential Equations	Tue-Thu 11:30-13:00	Huaiping Zhu
MATH 6605	Probability Theory	Tue-Thu 13:00-14:30	Neal Madras
MATH 6621	Advanced Mathematical Statistics	Tue-Thu 16:00-17:30	Yuehua Wu
MATH 6622	Generalized Linear Models	Tue-Thu 11:30-13:00	Tianyu Guan
MATH 6627	Practicum for Statistical Consulting	Mon-Wed 10:00-11:30	Kelly Ramsay
MATH 6632/4630	Applied Multivariate Statistical Analysis	Mon-Wed 16:00-17:30	Augustine Wong
MATH 6644	Statistical Learning	Tue-Thu 14:30-16:00	Divya Sharma
MATH 6652	Numerical Solutions to Differential Equations	Mon-Wed 13:00-14:30	Miles Couchman
MATH 6914	Data-Driven Finance using Python	Wed 16:00-19:00	Michael Chen
MATH 6936	Mathematical Epidemiology	Mon-Wed 10:00-11:30	Jane Heffernan

Summer 2027			
MATH 6300	Complex Analysis	S1, Tue-Thu 11:30-14:30	Alexey Kuznetsov
MATH 6643	Applications of Mixed Models	S1, Mon-Wed 10:30-13:30	George Monette
MATH 6912	Machine Learning in Finance	SU, Wed 14:30-17:30	Hongmei Zhu
MATH 6937	Practicum in Industrial & Applied Mathematics	S2, Tue-Thu 13:30-16:30	Jianhong Wu

Change from V1.1:

- Some updates on courses offered for Winter 2027 and Summer 2027.

Change from V1.2:

- Some updates on course schedule for Winter 2027 and Summer 2027.