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1 THE MASTER’S DEGREES

The Department of Mathematics and Statistics offers M.Sc. programs both in Division III, Engineering and Applied Sciences, and Division IV, Mathematics and Physical Sciences, of the School of Graduate Studies and Research. These programs fall into two categories. Pattern II is the standard program, and is completed within 12 months. It has the larger course requirement and thus allows students to fill in necessary background. Pattern I requires fewer courses but has a bigger research component. This program normally requires 16 to 24 months, although it can be completed in 12 months.

Students planning to continue into a Ph.D. program are encouraged to take the Pattern II Master’s degree. Depending on the selection of courses, some or possibly all of the courses taken for this program can be used to satisfy the breadth requirement for the doctoral degree thus allowing the student to begin their Ph.D. research sooner.

Students with an especially solid undergraduate degree and a strong interest in a particular research direction can be considered for the Advanced Entry Ph.D. Program directly out of undergraduate school. This program combines the Pattern II Master’s degree followed by Ph.D. study in one application. See Section 1.6 for complete details on this program.

1.1 The Master’s Programs and Requirements

The course requirements vary among the programs listed. Students should also refer to the Requirements for Degree Programs under the General Regulations of the online Graduate Calendar for information on the requirements for the Master’s degree programs.

DIVISION III - Engineering and Applied Sciences

The Pattern I or M.Sc.(Eng.) consists of a minimum of four one term graduate courses and a thesis. Students are strongly encouraged to take one or more courses from the department's core program especially if it is their intention to continue in our doctoral program.

The Pattern II or M.Eng. consists of a minimum of eight one term graduate courses and a research project. Students are strongly encouraged to take one or more courses from the department's core program especially if it is their intention to continue in our doctoral program.
DIVISION IV - Mathematics and Physical Sciences

Pattern I M.Sc. consists of a minimum of four one term graduate courses and a thesis. Students are strongly encouraged to take one or more courses from the department’s core program especially if it is their intention to continue in our doctoral program.

Pattern II (Mathematics) M.Sc. consists of a minimum of seven one term graduate courses and a research project. One of the courses must be the seminar (MATH 800*) and the other six are normally expected to represent at least three major areas in the mathematical sciences. Students are strongly encouraged to take one or more courses from the department’s core program especially if it is their intention to continue in our doctoral program.

Pattern II (Statistics) M.Sc. consists of a minimum of seven one term graduate courses and a research project. Students are strongly encouraged to take one or more courses from the department’s core program especially if it is their intention to continue in our doctoral program.

The Thesis (M.Sc.(Eng.) or Pattern I M.Sc.)

The thesis should demonstrate that the candidate is capable of original and independent work. The format of the thesis should conform to one of the two formats outlined in the General Forms of Theses.

The Project (M.Eng. or Pattern II M.Sc.)

The project should demonstrate that the candidate has a capacity for independent inquiry and knowledge of the important problems and the basic literature in the field. In the case of the Advanced Entry Ph.D. candidate the project should also demonstrate that the candidate has a substantial level of research ability. The format of the project should conform to one of the two formats outlined in the General Forms of Theses.

1.2 Supervision and Review of Progress

Students are encouraged to review the document Guidelines on the Roles and Responsibilities in Graduate Supervision

In most cases a supervisor will be chosen before the student is accepted into a Master's program. If a supervisor cannot be selected at that time an advisor will be appointed in time for the student’s arrival. In the case of the Advanced Entry Ph.D. student a supervisor must be chosen before the student is accepted into the program. In addition, a supervisory committee must be selected for the Advanced Entry Ph.D. student as soon as possible after arrival and no later than eight months after initial registration.
The supervisor (or advisor) is responsible for advising the student on an appropriate course selection and on monitoring the student’s progress through the program. In the case of the advisor s/he will also assist the student in selecting a supervisor by the end of the eighth month in the program at the very latest.

Master’s and Advanced Entry Ph.D. student progress is reviewed periodically. Students entering a second or subsequent year of study will be asked to formally report to the Graduate Committee on their progress and plans for completion. Please refer to Appendix C for further details.

1.3 Schedule for Program Completion

The Pattern I program is normally completed within 16-24 months of initial registration in the program. The Pattern II program has been designed to be completed within 12 months.

Students in both programs will spend the first two terms, fall and winter, satisfying the course requirements, after which they will complete their research project/thesis under the direction of their supervisors.

Students are encouraged to complete their degree requirements in a timely fashion. Please refer to Appendix B regarding the Department’s policy on graduate student funding.

1.4 The Thesis Examination (Pattern I)

A Master's thesis defense must be scheduled by the Graduate Coordinator through the School of Graduate Studies and Research.

The Examining Committee will consist of at least five members: the supervisor, a member of the department, the Department Head or his delegate, a member from another department on campus and the chairperson.

The exam is usually one and a half to two hours in length. The examination begins with an oral presentation by the student of approximately 20 minutes, and the balance of the time is devoted to questioning.

The possible outcomes that may be recommended by the Examining Committee are passed, referred or failed.

It is the responsibility of the supervisor, in consultation with the student, to propose the following two members of the Oral Thesis Examination Committee: a departmental examiner and an examiner from another department on campus. In addition it is also the supervisor’s responsibility to select a tentative date and time and to confirm examiner availability at least 15 working days prior to the examination date.
The Graduate Coordinator is responsible for selecting the remaining two members of the Oral Thesis Examination Committee, the Head's delegate and a Chairperson and for notifying the School of Graduate Studies of the impending examination at least 10 working days prior to the examination by submitting the appropriate form and a copy of the thesis.

The student is responsible for ensuring that the Graduate Secretary and each examiner receive a copy of the thesis at least 10 working days prior to the examination.

For complete details on the scheduling of the defense and the possible outcomes please see Thesis under Graduate Degree Programs in the General Regulations of the Graduate Calendar.

1.5 The Project Presentation (Pattern II)

The Master’s Project Presentation is scheduled by the supervisor.

The examining committee will consist of at least three members: the supervisor, and two other members, one doubling as chair. The examiner doubling as chair must be a member of the Department, but the third examiner may be from outside the Department. In the case of the M.Eng. examining committee the third member must be from another department within Division III.

The exam is to be of approximately one hour duration of which the first 20 minutes are devoted to an oral presentation by the candidate, and the balance of time is devoted to questioning.

The possible outcomes that may be recommended by the Examining Committee are passed or failed. In the case of a student registered in the Advanced Entry Ph.D. program, the outcomes are ‘passed with permission to continue to Ph.D. study’, ‘passed without permission to continue to Ph.D. study’ and ‘failed’.

It is the responsibility of the supervisor, in consultation with the student, to propose the two examiners. In addition it also the supervisor’s responsibility to select a tentative date and time and to confirm examiner availability for approval by the Graduate Coordinator at least 15 working days prior to the examination date.

The student is responsible for ensuring that each member of the examining committee receive a copy of the project 10 working days prior to the examination date. It is also the student’s responsibility to deliver a bound copy of the project to the Graduate Secretary after any required revisions have been made.

It is the responsibility of the Graduate Coordinator to notify the School of Graduate Studies and Research of the outcome of the project presentation.
In the case where the candidate has passed, minor revisions can be required by the Examining Committee. In the case where minor revisions are required, it is the responsibility of the supervisor to see that the suggested improvements are implemented.

If the student fails the examiners should submit to the Graduate Committee, in writing, reasons for their decision to fail the student, a recommendation regarding the possibility for a revision of the project, and (if that recommendation is positive) suggestions for the kinds of improvements required. The Graduate Committee will then meet to review the examining committee’s report and decide whether the student should be asked to withdraw from the program or should be given a chance to rewrite the project and present it again at a later date.

1.6 The Advanced Entry Ph.D. Program

This program is similar to the sequence consisting of a pattern II M.Sc. followed by a Ph.D. Students admitted into this program, provided that their work continues at a satisfactory level, receive an M.Sc. degree after completing the usual M.Sc. pattern II requirements (normally at the end of 12 months) and are then permitted to begin their Ph.D. programs without re-applying to graduate school.

Thus, during their first year, students in the Advanced Entry Ph.D. Program must satisfy the course requirements listed in the section describing the Pattern II Masters Degrees, together with a research project. However, they will be required to achieve a mark of at least 75% (in place of the usual 65%) in each required course not marked on a PASS/FAIL basis; and at the time of the presentation of their Masters Project, instead of the usual two outcomes, the Examining Committee will consider three possible outcomes:

i) passed with permission to continue to Ph.D. study;
ii) passed without permission to continue to Ph.D. study;
iii) failed.

The first outcome will be used when the Examining Committee feels that the quality of the project and its presentation are consistent with what can be expected of a student preparing to begin original research. The second outcome will be used to indicate that the Examining Committee feels that the project and its presentation leave serious doubt about the student's ability to engage in the kind of research required for a Ph.D. program. This outcome will allow the student to receive the M.Sc. degree, but will mean that the student will not be allowed to continue into Ph.D. study without re-applying to graduate school, and undergoing the review associated with that process.

In the two cases where the candidate has passed (with or without permission to continue) minor revision may be required. The handling of these revisions, as well as the procedure to be followed in case of failure, is described in detail in Section 1.5. A student who fails the project presentation will not be permitted to continue in the Advanced Entry Ph.D. program, even if the student is permitted to re-take the examination and subsequently passes it, resulting in the awarding of the M.Sc. degree.
2 THE DOCTORAL DEGREE

The Ph.D. program involves three stages: preparation for research (course and language requirements), certification that the preparation is adequate (comprehensive examination) and thesis research.

2.1 The Program Requirements

Breadth of Knowledge

The breadth requirement will consist of a selection of six half course equivalents in which three major areas of the mathematical sciences are represented. Depending on the student’s area of specialization, a minimum of three or four credits in areas covered by the department’s core program is required. See Appendix E for complete details on the department’s core program. The program may include graduate courses taken during a Master’s program at Queen's or elsewhere.

This requirement will usually be considered satisfied when all approved courses are passed (≥65%) and the overall average for these six courses is at least 75%.

Depth of Knowledge

The depth requirement will consist of a selection of at least four advanced half courses in the candidate’s chosen field. The program may include graduate courses taken during a Master’s program at Queen’s or elsewhere and can include courses used to satisfy the breadth requirement but will not include credits earned from the core program and will rarely include the courses which are jointly offered to undergraduates.

This requirement will usually be considered satisfied when the approved courses are passed (≥65%) and the overall average for these four courses is at least 80%.

Language

If a significant amount of reference material in the student's chosen field of study is in a language other than English a student may be required to obtain a reading knowledge of that language. For any language required there are two ways the student may satisfy the requirement: (i) by taking a language course and obtaining a grade of at least 65%; or, (ii) by satisfactorily translating part of a technical article. In the latter case the student's supervisor will choose a text, of about 700 words, for translation. The student will have two hours to do the translation, with the aid of a dictionary. The translation and article will then be given to the Coordinator of Graduate Studies for transfer to a member of the Department for grading. The marker of the language examination will keep in mind that the student is not expected to translate flawlessly but to be able to paraphrase without distorting content.
The Comprehensive Examination

The purpose of the examination is to assess the candidate in two aspects: the suitability and feasibility of the proposed research area; and, the candidate's competence to undertake that research. This is an oral examination expected to last from one to two hours. Please see Appendix A for complete details on the comprehensive examination.

The Thesis

The doctoral thesis must be original and be of such value as to merit publication. The format of the thesis should conform to one of the two formats outlined in the General Forms of Theses.

2.2 Supervision and Review of Progress

Students are encouraged to review the document Guidelines on the Roles and Responsibilities in Graduate Supervision.

While the day to day supervision of a student's progress is monitored by the supervisor the student's overall progress in the program is monitored by a supervisory committee consisting of the supervisor as chair and two other faculty who are also members of the Graduate School and normally members of the department.

The Supervisory Committee’s responsibilities will include advising the student on proposed research and monitoring the student's research progress, monitoring the student’s progress through and Ph.D. program by deciding upon and recommending to the Graduate Committee, a depth requirement, language requirement if appropriate, and examiners for the student’s comprehensive and final oral examinations.

Students are expected to formally report to the Graduate Committee on their progress once a year, usually in the Fall. A formal request for this report (see Appendix C) will come from the Graduate Coordinator. The Graduate Coordinator will, on behalf of the Graduate Committee, review student progress reports and approve program requirements, consulting the committee only in those cases that seem problematic.
2.3 Schedule for Program Completion

Students are encouraged to complete their degree requirements in a timely fashion. Please refer to Appendix B regarding the Department's policy on graduate student funding.

Upon arrival the student will, in consultation with her/his supervisor, complete and submit *Program Sheet I* (Proposed Breadth Requirement and Supervisory Committee) and possibly Program Sheet II (Proposed Depth and Language Requirement).

By the end of the eighth month the student will have satisfied the breadth requirement and possibly taken some courses aimed at satisfying the depth requirement.

By the end of the twelfth month the student will, in consultation with the supervisory committee, complete and submit *Program Sheet II* (Proposed Depth and Language Requirement) and possibly *Program Sheet III* (Proposed Comprehensive Examining Committee and Examination Date).

By the end of the sixteenth month the student will, in consultation with the supervisory committee, complete and submit *Program Sheet III* (Proposed Comprehensive Examining Committee and Examination Date).

By the end of the eighteenth month the student will have taken the Comprehensive Examination.

By the end of the twenty-fourth month the student will have satisfied the depth requirement and passed the Comprehensive Examination.

By the end of the forty-sixth month the student will in consultation with the supervisory committee complete and submit *Program Sheet IV* (Proposed Thesis Examining Committee and Examination Date).

As noted above in section 2.2 students are expected to formally report to the Graduate Committee on their progress once a year, usually in the Fall. A formal request for this report (see Appendix C) will come from the Graduate Coordinator.
2.4 The Thesis Examination

A doctoral thesis defense must be scheduled by the Graduate Coordinator through the School of Graduate Studies and Research.

The Examining Committee will consist of at least six members: the supervisor, a member of the department, the Department Head or his delegate, a member from another department on campus, a member external to the University, and the chairperson.

The exam is usually two to three hours in length. The examination begins with an oral presentation by the student of approximately 20 minutes, and the balance of the time is devoted to questioning.

The possible outcomes that may be recommended by the Examining Committee are passed, referred or failed.

It is the responsibility of the supervisor, in consultation with the Supervisory Committee and the student, to propose the following three members of the Oral Thesis Examination Committee: departmental examiner; an examiner from another department on campus; an examiner external to the University. In addition it is also the supervisor’s responsibility to select a tentative date and time and to confirm examiner availability at least 30 working days prior to the examination date.

The Graduate Coordinator is responsible for selecting the Head’s delegate, and for notifying the School of Graduate Studies of the impending examination at least 25 working days prior to the examination by submitting the appropriate form and a copy of the thesis.

The Dean of the Graduate School is responsible for appointing a Chairperson of the examination.

The student is responsible for ensuring that the Graduate Secretary and each examiner receive a copy of the thesis at least 25 working days prior to the examination.

For complete details on the scheduling of the defense and the possible outcomes please see Thesis under Graduate Degree Programs in the General Regulations of the Graduate Calendar.
The Doctoral Comprehensive Examination

The purpose of the Ph.D. Comprehensive Examination is to assess the candidate in two aspects:

i) the suitability and feasibility of the candidate's proposed Ph.D. research area;
ii) the candidate's competence to undertake that research.

The Comprehensive Examination will be held 18 months after the student’s registration in the Ph.D. program, or earlier. Normally, therefore, students who arrive in September will be examined in the month of February, and those who arrive in January will be examined in June.

The Research Proposal

In preparation for the Comprehensive examination, the candidate will prepare a research proposal. Good research usually takes place in the context of important unsolved problems or interesting new discoveries. In the research proposal, and at the comprehensive examination, the candidate should indicate a good basic understanding of this context and should be able to give a preliminary account of the relevant literature. If possible, the candidate should outline some to the research approaches planned. Exceptionally the candidate may have some preliminary results. These should then be included.

The format of the document should be consistent with a thesis format. In particular, the document should have a title, an abstract, an introduction with a literature review, a discussion of the question(s) of interest and possible methods to be used, any (partial) solutions obtained by the time of the comprehensive examination, and a bibliography.

The Examination

The examination is oral, and expected to last from one to two hours. At the start, the chairman of the Examining Committee will ask the candidate to present a 20 to 30 minute summary of his/her research proposal, which is distributed in written form to the Examining Committee two weeks prior to the exam. The Committee members will then proceed to question the candidate to satisfy themselves that she/he is competent to carry out the necessary work for the thesis. This involves the candidate defending her/his research proposal, and includes questioning on areas related to the proposed research area.

Immediately following the questioning the candidate is asked to withdraw at which time the Committee considers the quality of the submitted proposal, the oral presentation, and the response to the questioning. The Committee then determines whether the student has passed or failed by majority vote of the examiners on the committee (see below).

The candidate will be informed immediately by the Chairman as to the outcome of the examination. In the case of failure the candidate will receive a copy of the recommendation of the committee within two days of the examination.
The categories of outcome that may be recommended by the Examining Committee are:
1) passed
2) failed with the possibility of re-examination. In this case, the re-examination should take place within four months.
3) failed. In this case, the candidate will be asked to withdraw from the program.

The Examining Committee

The Examining Committee will consist of the Coordinator of Graduate Studies (or her/his appointee) as impartial chair, and three voting members which includes the supervisor and two other members from the Faculty of the School of Graduate Studies and Research. In special circumstances members may be chosen from outside Queen’s.

The responsibilities of the chair include informing the candidate of the outcome of the examination and filing the standard report for the Department which indicates the outcome of the examination and returning this report to the Graduate Secretary. In addition, if the outcome of the examination is either category 2 or 3, the chair will prepare, and submit to the Graduate Secretary, a one page report outlining the basis for the Committee’s decision. A copy of this report must be made available to the student within two days of the examination.

The Role of the Supervisor

The duties of the supervisor, in consultation with the candidate's Supervisory Committee, include: choosing the voting members of the committee for the Departmental Graduate Committee's approval; deciding upon the area of questioning; reporting these details to both the candidate and the Examining Committee well in advance of the examination so that they can properly prepare for the examination; depending on the outcome of the examination overseeing the implementation of minor revisions.

Appeals

If the candidate believes he/she was dealt with unfairly by the committee he/she may appeal the decision in writing to the Coordinator of Graduate Studies within two weeks of the date of the exam, giving the details of the basis for the appeal. Upon receiving such a request the Coordinator will inform the Head and they will jointly carry out a review of the grade. The Coordinator will then inform the student in writing within two weeks the outcome of the review.

Penalties

A Ph.D. candidate who fails to meet the deadline for the Comprehensive Examination may be subject to the following penalties:
1. The candidate will not be allowed to serve as a Teaching Fellow until the requirement is satisfied.
2. If the Comprehensive Examination is not taken within the first 21 months the Department will recommend to the School of Graduate Studies and Research that the candidate be asked to withdraw from the Ph.D. program.
APPENDIX B

Departmental Policy on Funding

The following is the Department's policy with respect to the duration and conditions of financial support for graduate students.

1. The normal period of financial support for graduate students is five terms for Pattern I Master's students, 3 terms for Pattern II Master's students and three years for Doctoral students. Continued financial support for a sixth term in the case of Pattern I Master's students and for a fourth year in the case of Doctoral students will be considered only if

i) the supervisor strongly recommends the continued financial support and
ii) it appears that the thesis will be completed during this additional period.

For a student enrolled in the Advanced Entry Ph.D. program, the normal period of financial support is four years. Continued support for a fifth year will be considered under the conditions listed above.

2. Financial support of graduate students is conditional upon their being registered as full-time, on-campus students and upon their making satisfactory progress toward the completion of their program of study.
APPENDIX C

Review of Student Progress by the Departmental Graduate Committee

Students are asked to report on their activities to the Graduate Committee periodically. The purpose of this reporting is three-fold: It helps the student to review the previous terms, to note the progress made, and to set priorities for the coming term(s). It also ensures that the supervisor or the supervisory committee in the case of the Advanced Entry Ph.D. student or doctoral student, reviews the student's progress periodically, and remembers to serve the student with advice regarding the direction of research activity. Finally, it allows the department to keep track of the progress of its graduate students, and to budget its resources in a manner that will facilitate this progress.

Students are asked to report briefly but informatively using the headings provided below.

- List the courses you took or are taking this calendar year.
- Describe the reading you have done outside that required for the courses listed above.
- List the seminars and colloquia you have attended or are attending this calendar year.
- List the courses and seminars you are currently attending.
- List any departmental course/seminar presentations you have made this calendar year.
- Describe the progress made last term on your research and on project/thesis writing.
- List any other activities that you think are relevant to your supervisor's and our assessment of your progress.
- How and when do you propose to satisfy the remaining requirements for your degree?

A formal request to complete a Ph.D. Annual Progress Report Form or M.Sc. Annual Progress Report Form will come from the Graduate Coordinator.
APPENDIX D

Procedures for the Review of Grades in Graduate Courses

1) A student who wishes to question a grade received in a graduate course in the Department should request a review of the grade by the instructor(s). This request (i) must be made in writing and addressed to the instructor(s) of the course with a copy being given to the Coordinator of Graduate Studies, (ii) must be made within two weeks of the time of the grade is announced, and (iii) must explain the reasons for appealing the grade. The instructor(s) should reach a decision and communicate it to the student and the Coordinator of Graduate Studies in writing within two weeks of receiving the student's request.

2) A student who is not satisfied by 1. may request a review of the grade by the Coordinator of Graduate Studies and the Head of the Department. This request (i) must be made in writing and addressed to the Coordinator, (ii) must be made within one week of receiving the communication from the instructor(s) mentioned in 1., and (iii) must contain reasons for appealing the decision. Upon receiving such a request the Coordinator will inform the Head and they will jointly carry out a review of the grade. The Coordinator must inform the student in writing of the decision he or she and the Head have reached within two weeks of receiving the student's request, and this reply may recommend that

i) the previous grade stand,
ii) the grade be modified, or
iii) the student by re-examined.

3) In case the Coordinator of Graduate Studies or the Head of the Department is an/the instructor in the course then the procedure in 1. and 2. will be modified in an appropriate way.

4) No further appeals in the matter can be made within the Department. The student may elect to invoke the general University appeal procedure as stated in the Calendar of the School of Graduate Studies and Research.
The Core Program

To ensure that our graduate students have basic knowledge in some fundamental areas of mathematics and statistics doctoral students are, depending on their area of specialization, expected to have or acquire a minimum of three or four graduate credits in areas covered by the department’s core program. Normally, pure mathematics students will be required to have or acquire four credits and applied mathematics students and statistics students will be required to have or acquire three credits.

In order to pass a core course students must earn a grade of at least 50% on the final examination and a final grade of at least 65% in the course.

Students who have already covered the material of a particular core course in a previous graduate program and achieved first class standing in that course may request a core course exemption. Requests for exemptions are made by completing the Core Course Exemption Form by the end of the second week of classes of the core course for which the exemption is being requested. Note that exemptions require the approval of the supervisor, core course instructor and the graduate coordinator.

Listed below are the six courses which make up the Department’s core program. From time to time other courses may be offered as core to the doctoral program. Such courses will be advertised as core courses.

**Math-891* Core Course in Analysis I**
This course provides basic knowledge in real and complex analysis at the graduate level on the following topics: Lebesgue measure and integration theory; elementary Hilbert space theory; examples of Banach space techniques.
Three term-hours, fall, lectures

**Math-892* Core Course in Analysis II**
This course provides basic knowledge in real and complex analysis at the graduate level on the following topics: basic theory of Fourier transforms; basic elements of spectral theory and Banach algebras; complex analysis.
Three term-hours, winter, lectures
Math-893* Core Course in Algebra I
This course provides basic knowledge in algebra at the graduate level on the following topics: elementary theory of groups; elementary theory of rings and modules; Galois theory
Three term-hours, fall, lectures

Math-894* Core Course in Algebra II
This course provides basic knowledge in algebra at the graduate level on the following topics: representation theory of finite groups through characters; advanced theory of modules; advanced theory of rings.
Three term-hours, winter, lectures

Math-895* Core Course in Probability Theory
This course provides basic knowledge in probability at the graduate level. Topics will include: basic notions and concepts of Probability Theory; characteristic functions; law of large numbers and central limit theorem; martingales; stochastic processes.
Three term-hours, fall, lectures

Math-896* Core Course in Mathematical Statistics
This course provides basic knowledge in mathematical statistics at the graduate level. Topics will include: Classical and Bayesian inference, Multivariate Gaussian distribution and its applications in Statistics; decision theory; basic techniques of non-parametric estimation
Three term-hours, winter, lectures