

A GUIDE TO OUR GRADUATE PROGRAMS
Department of Mathematics & Statistics
Dalhousie University
2011/2012

August 4, 2011

Disclaimer: In case of inconsistency between the Faculty of Graduate Studies information and this document; the Faculty of Graduate Studies information takes precedence.

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1 Introduction

Welcome to Dalhousie University and the Department of Mathematics & Statistics. This handbook is written to help graduate students and faculty navigate their way through our programs. Some of the regulations listed here apply only to our department, while others are university-wide regulations designed by the Faculty of Graduate Studies (FGS). Therefore, we encourage everyone to read the FGS Calendar and FGS website (<http://www.dalgrad.dal.ca>) for additional information. In the case of any discrepancy between this handbook and FGS Calendar, the FGS Calendar will have precedence. A list of Mathematics and Statistics faculty and their areas of expertise can be found on our webpage (<http://www.mathstat.dal.ca>), along with a list of present graduate students and office staff.

This document is a work in progress and will evolve partly in response to the needs of students. Suggested changes and additions can be sent to your graduate coordinator.

We would like to thank the Physics department, who generously allowed us to use their graduate handbook as a template for this document.

1.1 Short Checklist for New Students

- *Do you know your Banner ID number (B00 - - - -)?* This would have been provided to you in your letter of acceptance from the Registrar. You will need this number to register, obtain a Dalhousie Student ID card and to set up your Net ID. To obtain your Student ID Card, go to the Dalhousie ID Card Office, located at 1443 Seymour St. (Building C710 on the Dalhousie Campus Map <http://campusmap.dal.ca/>).

To set up your Net ID go to (<https://wa.its.dal.ca/newuser>). Your *@dal.ca* email is the main source of email correspondence at Dalhousie University. All messages sent by Dalhousie University will go to your Dalhousie email address. You can also check the status of your student account, payroll and stipend information once you have set up your Dalhousie Net ID.

- *Have you registered?* All graduate students must register for all three terms (Fall, Winter and Summer) for the upcoming academic year. In addition to any classes you will take during the year, you MUST register in REGN 9999. Please see Section 5.9 for more information.

If you are not registered, you will not receive your monthly stipend if you are paid through Dalhousie.

- *Have you checked with the graduate secretary?* Paula Flemming is the department's graduate secretary. She will assign you a shared office space (\$20 key deposit), a mail slot in the mail room, a computer account and a code for the front door. Your *@mathstat.dal.ca* email is the main source of email correspondence from the department.
- *Have you met with your graduate coordinator?* Your graduate coordinator will give you information about the program and talk to you about courses and possible supervisors, if you do not already have one. Early in the term you will have to fill out your program form (Section 7.2), and it is therefore important to start thinking about it as soon as possible.
- *Have you returned your "Direct Deposit" form and a void cheque to the Math & Stats Office or Payroll Services?* All payments (including expense and travel reimbursement) to Dalhousie students, faculty and staff are by direct deposit. It is important to provide Payroll Services

with your banking information so that you will receive your monthly stipend. Please note that the monthly stipend is deposited at the end of each month.

- *Have you taken care of your Health/Dental and Medical Coverage?* Please see Section 6.5 for details.

1.2 Departmental Contact Information

Our department consists of the Mathematics Division and the Statistics Division. Each division has a director and graduate coordinator who are responsible for running the undergraduate and graduate programs, course offerings, admission of graduate students and so on. Both divisions operate under the Department of Mathematics & Statistics, and share the facilities of the Chase Building. The department chair and staff serve both divisions.

The graduate coordinators, with the help of the graduate secretary, are the liaison between the graduate students in the department and the university. They look after the running of the graduate program and make sure all students are taking the appropriate steps towards the completion of their degrees. Students should feel free to bring all concerns and questions to their graduate coordinator in their division. Details of responsibilities of the graduate coordinator can be found at the website of the Faculty of Graduate Studies.

In cases where a conflict of interest prevents a student from approaching the graduate coordinator, students are encouraged to take the matter to the division directors, the department chair, graduate secretary or department administrator and ask for further advice.

- Dr. Keith Johnson: Mathematics Graduate Coordinator (*johnson@mathstat.dal.ca*)
Room 313, (902) 494-3598
- Dr. David Hamilton: Statistics Graduate Coordinator (*hamilton@mathstat.dal.ca*)
Room 102, (902) 494-3568.
- Paula Flemming: Graduate Secretary (*paula@mathstat.dal.ca*)
Room 219, (902) 494-3214.
- Dr. Karl Dilcher: Department Chair (*dilcher@mathstat.dal.ca*)
Room 325/219, (902) 494-3784/6913.
- Dr. Robert Milson: Mathematics Director (*milson@mathstat.dal.ca*)
Room 203, (902) 494-6366.
- Dr. Hong Gu: Statistics Director (*hgu@mathstat.dal.ca*)
Room 101, (902) 494-7161.
- Gretchen Smith: Department Administrator (*gretchen@mathstat.dal.ca*)
Room 219, (902) 494-6911.
- Balagopal Pillai: Systems Administrator (*pillai@mathstat.dal.ca*)
Room B004, (902) 494-3204.

2 Preview of Our Graduate Programs

2.1 Admission Requirements

Candidates must satisfy the general requirements for admission to the Faculty of Graduate Studies. For details on admission, fees, course listings and general information see the Graduate Calendar (<http://gr.cal.dal.ca/index.html>) and also see Section 4 of this document. MSc candidates will normally be expected to hold a degree recognized by Dalhousie University at the equivalent of a Dalhousie Bachelor's degree with Honours. PhD candidates will normally be expected to hold a first-class MSc degree (or equivalent) from a recognized university. To ensure consideration for scholarship funds, applications should be made by January 15, regardless of when during the year you intend to start your program.

2.2 Mathematics and Statistics Programs

The Department of Mathematics & Statistics offer programs leading to the degrees of MSc and PhD in many research areas. You can find a description of our research groups at this website (<http://www.mathstat.dal.ca/research.html>).

Pure and applied math faculty research interests include:

algebra	differential geometry
algebraic topology	functional analysis
applied mathematics	general relativity theory
category theory	graph theory
combinatorics	logic
combinatorial game theory	harmonic analysis
commutative algebra	number theory
differential equations	wavelet theory

Statistics faculty research interests include:

bioinformatics	linear and nonlinear regression
data analysis	robust statistics
experimental design	time series analysis
machine learning	statistical genetics
molecular evolution	statistical inference
multivariate analysis	

Graduate students in the statistics division can also take part in one or more applied projects through their participation in the activities of the statistical consulting service.

2.3 Requirements for a Master's (MSc) Degree

- At least three full-credit classes (18 credit hours), not including seminar classes, at the graduate level to be chosen in consultation with a department advisor (i.e. a potential supervisor or the graduate coordinator). In addition, students whose preparation in a particular area of mathematics is deficient will be required to complete appropriate classes which will be designated by the advisor;
- Attendance and participation in seminars;

- A satisfactory thesis;
- Students are required to give an oral presentation (defence) of their thesis and at that time to answer questions about the thesis. This presentation will be made after the thesis is in the hands of the student's committee and will be taken into account when the committee makes its decision;

2.4 Requirements for a Doctor of Philosophy (PhD) Degree

- At least two full-credit classes (12 credit hours);
- Comprehensive examinations which must be taken for the first time within 12 months and successfully completed within 16 months of registration in the program;
- Attendance and participation in an appropriate seminar;
- Preparation and defence of a satisfactory research thesis;

2.5 Courses We Offer

2.5.1 Mathematics Courses

Below is a list of the most frequently offered graduate courses. A selection of the following courses will be offered in any given year.

MATH 5010.03: Introduction to Measure Theory and Integration*
 MATH 5020.03: Analytic Function Theory*
 MATH 5025.03: Commutative Algebra I
 MATH 5045.03: Advanced Algebra I*
 MATH 5055.03: Advanced Algebra II*
 MATH 5065.03: Algebraic Geometry
 MATH 5066.03: Advanced Statistical Theory I
 MATH 5070.03: Topics in Number Theory
 MATH 5090.03: Probability
 MATH 5135.03: Introduction to Category Theory
 MATH 5136.03: Topics in Category Theory
 MATH 5140.03: Introduction to Functional Analysis
 MATH 5170.03: General Topology
 MATH 5180.03: Introduction to Algebraic Topology
 MATH 5190.03: Ordinary Differential Equations
 MATH 5195.03: Topics in Topology and Functional Analysis
 MATH 5200.03: Ordinary Differential Equations - Qualitative Theory
 MATH 5220.03: Introduction to Partial Differential Equations
 MATH 5230.03: Partial Differential Equations
 MATH 5250.03: Asymptotic Analysis
 MATH 5320.03: Combinatorial Optimization
 MATH 5330.03: Topics in Graph Theory
 MATH 5340.03: Discrete Random Structures
 MATH 5360.03: Combinatorial Modelling
 MATH 5410.03: Topics in Cosmology

MATH 5500.03: Introduction to Harmonic Analysis
MATH 5540.03: Applied Analysis*
MATH 5650.03: Relativity and Cosmology
MATH 5660.03: Automata and Computability
MATH 5680.03: Topics in Logic and Computation
MATH 5800.03: Introduction to Mathematical Research
MATH 5900.03: Combinatorial Game Theory.

* These courses are *core courses*. They are offered every year, and mathematics students can use them to complete their PhD Comprehensive Exam requirement; see Section 9.3 for more details.

NOTE: Students interested in pursuing a degree program in Applied and Computational Mathematics designed to prepare them for the work environment should consider the following classes: Math 5190, Math 5200, Math 5220, Math 5230, Math 5270, Math 5290, Math 5300, Math 5310, Math 5400 and one of Stat 5080, Stat 5370 or Stat 5620.

2.5.2 Statistics Courses

A selection of the following courses will be offered in any given year.

STAT 5066.03: Advanced Statistical Theory I.
STAT 5067.03: Advanced Statistical Theory II.
STAT 5070.03: Multivariate Distributions.
STAT 5075.03: Multivariate Analysis.
STAT 5090.03: Probability.
STAT 5100.03: Survival Analysis.
STAT 5300.03: Topics in Statistics and Probability.
STAT 5350.03: Applied Multivariate Analysis.
STAT 5360.03: Robust Statistics.
STAT 5370.03: Stochastic Process.
STAT 5390.03: Time Series Analysis I.
STAT 5410.03: Advanced Topics in Time Series Analysis.
STAT 5500.03: Topics in Advanced Statistics.
STAT 5550.03: Longitudinal Data Analysis
STAT 5570.03: Statistical Genetics
STAT 5620.03: Data Analysis.
STAT 5630.03: Statistical Methods in Molecular Evolution.
STAT 5640.03: Advanced Analysis of Complex Survey Data.
STAT 5700X/Y.03: Statistical Consulting Practicum.
STAT 5750.03: Statistical Data Mining.

3 Financial Information

If you are admitted to our programs with funding, you are guaranteed a minimum level of financial support during the program, so long as you are making satisfactory progress and have met the conditions of financial support. Departmental scholarships will normally be provided for one year to an MSc student, three years to a PhD student in Mathematics, and four years to a PhD student in Statistics. More information appears in this section.

Foreign students must pay a differential fee (see Section 4.5.1). To help offset this fee, the base level of support for foreign students is increased by this amount from departmental sources.

Most of our students hold external scholarships. Even when students start their program with departmental funding, they are expected to apply for external funding during their first year. The purpose is two-fold: external scholarships are prestigious additions to a student's cv, and contribute significantly to the student's success in seeking further funding and postdoctoral positions. Also, every student receiving external funding allows us to reallocate our funding to recruit new students into our graduate program.

3.1 Non-departmental Funding

The most common sources of non-departmental scholarships are listed below. There are several other scholarships that are awarded each year. You can check the list at (<http://dalgrad.dal.ca/currentstudents/funding/>). We usually send out reminders when these are advertised.

3.1.1 NSERC

NSERC (Natural Sciences and Engineering Research Council) applications are due in the Fall. All eligible students (Canadian citizens and permanent residents) are expected to apply. Applications are sent by the department to the Faculty of Graduate Studies, and candidates are selected university-wide to be nominated for the competition. Please see (<http://www.nserc-crsng.gc.ca/>) for further information on NSERC scholarships.

3.1.2 Killam Scholarships

The department will nominate highly qualified students to apply for Killam scholarships in January. Canadian Citizens may apply for Killam scholarships only if they have applied for NSERC support in the previous fall. Killam scholarships can be awarded to incoming students in both MSc and PhD programs; however, currently registered students may apply for Killam scholarships only if they are enrolled in a PhD program, or if they have been accepted to a PhD program at Dalhousie University. See (<http://killamtrusts.dal.ca/apply/predoctoral/index.php>) for more information on Killam predoctoral scholarships.

3.1.3 The President's Awards

The President's awards are for students starting PhD programs who have a full doctoral scholarship from NSERC (PGSD or CGSD) or Killam (Doctoral). The award will cover tuition - but not international differential fees or other student fees - for up to the first two years for PhD students. Students must have a complete and accurate program form and progress report before the second year award will be paid. The award will be granted for each term that the student is

registered as a full time student;
paying full tuition (i.e., not continuing fees);
receiving a full doctoral scholarship from one of the specified agencies;
tuition is not covered by any other award, agency or government.

For eligible students, the Faculty of Graduate Studies will notify those students and departments following admission. The award will be verified and applied to the student's tuition each term for the duration of the award. Students must have a complete and accurate program form and progress report before the second year award will be paid.

3.2 Departmental Funding

Students without external scholarship support are generally awarded Dalhousie Graduate Scholarships from funds which come to the department from the university and from individual faculty member's research grants. According to FGS regulations, maximum eligibility for FGS scholarships is two Master's years and the first five Doctoral years. The current level of support in our department is as follows.

- **Mathematics Division:** One year for an MSc student and 3 years for a PhD student (we will make every effort to maintain this level of funding for a 4th year PhD student).
 - MSc: \$11,000 above tuition costs and differential fees
 - PhD: \$14,000 above tuition costs and differential fees
- **Statistics Division:** One year for an MSc student and 4 years for a PhD student.
 - MSc: \$10,000 above tuition costs and differential fees
 - PhD: \$13,000 above tuition costs and differential fees

To see the 2011-2012 tuition and fees, please see Section 4.5.

3.3 Regulations on Top-ups

We often top-up scholarships of incoming and continuing students in order to recruit and retain highly qualified students in our department. These top-ups are regulated by FGS. A very brief summary of the most relevant rules to the department of Mathematics & Statistics are listed below. For details, please see the document "Procedures for Approval of Graduate Scholarships at Dalhousie" at (http://dalgrad.dal.ca/docs/procedures_for_approval_of_graduate_scholarships.pdf). For help in interpreting the rules, you can talk to your graduate coordinator.

- FGS scholarship awards to individual students may not exceed the Killam Scholarship, i.e., \$20,000 for Master's students, \$25,000 for Doctoral students.
- Departmental (FGS) scholarships can be used to top-up scholarship salaries as long as the total value of all scholarships does not exceed \$28,000.
- TA salary is not considered scholarship money and does not enter the above calculations.
- As of Summer 2011, NSERC scholarships may be topped up with faculty NSERC grants.

So an NSERC PGSD Scholarship holder who earns \$21,000 a year can receive a maximum of \$7,000 in departmental FGS scholarships. A Killam Level II Scholarship holder (\$25,000) can receive a maximum of \$3,000 in departmental FGS scholarships, and an NSERC CGS scholarship (\$35,000) recipient cannot receive any top-ups from FGS scholarships.

3.4 Teaching Assistantships (TA)

Students usually receive financial support from Teaching Assistantships (TA) as part of their departmental funding package. TA support is governed by rules of The Canadian Union of Public Employees, Local 3912 (<http://www.3912.cupe.ca/>). TA work is 90 hours for each of the Fall and Winter terms for a total of 180 hours for the 8-month academic year. These hours are assigned for marking, tutoring in our Mathematics & Statistics Learning Centre (<http://www.mathstat.dal.ca/learning/learningcenter.html>) or giving first year class tutorials which works out to approximately 7 hours a week.

In order to maintain full-time status and continued scholarship/fellowship support, a student may work no more than 16 hours per week, including a maximum of 10 hours as a teaching assistant/marker/demonstrator. Students registered as part-time are not eligible for scholarship or Dalhousie Graduate Student Scholarship support.

The current TA salary is \$3,870 per academic year. The Centre for Teaching & Learning offers TA support and workshops, please see Section 6.10 for more details.

3.5 Teaching Opportunities

Most PhD students and some MSc students will have the opportunity to teach a course as the main instructor during their program. Typically these openings are for summer courses, but there could be some during the Fall and Winter semesters as well. These job openings are announced by the department via email.

3.6 Scholarship Payments

The procedures for calculating fellowship amounts are complex, and mistakes may occur. Students typically receive a fellowship letter during the summer stating their total rate of pay for the upcoming year. Students are encouraged to discuss this letter with their supervisor, graduate coordinator, or departmental administrator if there is anything about the letter they do not understand. They are also encouraged to monitor their subsequent pay cheques to ensure consistency with their fellowship letter.

Scholarship payments are divided equally over the terms covered by the award, usually Fall (September to December), Winter (January to April) and Summer (May to August). Fees will be deducted at the beginning of each term and the remainder paid in equal monthly instalments. Please note that the monthly payments of scholarships are done near the end of each month.

Example: \$22,000 scholarship for a PhD student (minus the \$3,620 TAship which is paid on a biweekly basis from Sept.1-Apr.30) is \$18,380 paid equally in three instalments of \$6126.66 each. Fees in each of Fall, Winter and Summer are then deducted from each of the three instalments and the remainder paid to you. Fees for 2009/2010 were as follows:

MSc: \$8286 (Fall \$3033 + Winter \$2662 + Summer \$2591)
 PhD: \$8613 (Fall \$3142 + Winter \$2771 + Summer \$2700).

3.7 Lett Bursary

The Patrick Lett Student Assistance Bursary is a fund with the purpose of giving financial aid to graduate students who are having difficulties getting assistance from other sources.

This bursary is primarily intended for students who have run out of regular funding; this means that students in their first year of an MSc program or in the first two or three years of a PhD program are not usually funded by the Lett Bursary, unless there are special circumstances.

If you think you may qualify, you can find an application form and instructions on the department website under (<http://www.mathstat.dal.ca/scholar.html>), or pick up hard copies from the department office.

There is a similar source of emergency funds called “The Faculty of Graduate Studies Emergency Bursary”. Please see (<http://dalgrad.dal.ca/currentstudents/funding/bursaries/#fgs>) for more information.

4 Application and Admission

4.1 Language Requirements

All applicants whose first language is not English must receive a sufficiently high mark on an English language proficiency test (TOEFL 580 (written), 237 (computer), 92 (internet); MELAB 85; IELTS 7). The language competency test may be waived if the applicant has completed a degree at a recognized university where the language of instruction is English.

4.2 Deadlines

Graduate programs in mathematics and statistics are designed to start in September, but in some circumstances applicants may start in January or May.

All students applying for funding:

Your application and supporting documents should reach the university by **January 15**.

Canadian students:

Applications should be received by the university no later than June 1 for a September start date (all supporting documents must be received by this deadline). If you are applying for scholarships and departmental funding, your application and documents should reach the university by January 15. Applications received after June 1 are not guaranteed to be processed in time for September admission.

Non-Canadian students:

Your application must be received no later than April 1 for a September start date. If you are applying for scholarships, all documents must reach us by January 15. Applicants who require a student visa and are not funded by the university or an officially-recognized funding agency must provide proof of financial ability with their application. Canadian immigration is increasingly rigorous about requiring proof of sufficient financial support to complete the program of studies. Also, given the length of time some student visa applications can take, foreign students are encouraged to apply early so they can be here for the start of their program.

4.3 Application Package

An application package should at least contain (for details see <http://dalgrad.dal.ca/prospectivestudents/admissions/>):

- application forms,
- official transcripts,
- statement of research interests,
- a curriculum vitae,
- at least 2 letters of reference, and
- TOEFL scores or equivalent English Language Competency tests for international applicants (see Section 4.1).

To obtain application information and forms go to (<http://www.registrar.dal.ca/apps>). Alternatively, you can request a paper copy of the form to be sent from the Registrar's Office at: admissions@dal.ca or (902) 494-2156. Please allow 2-3 weeks for delivery or 6-8 weeks for overseas requests. One copy of Part A of the application form along with the application fee must be sent to the Registrar's Office. All supporting materials (including references, official transcripts from all post-secondary institutions attended, official GRE scores, official TOEFL scores, etc.) are to be sent directly to the department:

Graduate Secretary
Mathematics and Statistics
6316 Coburg Rd.
PO BOX 15000
Halifax, Nova Scotia
Canada B3H 4R2

Note that supporting documents (transcripts, letters of reference, etc.) will be verified for authenticity. Applicants submitting fraudulent documents may have their names published on the listserv of the Association of Registrars of Universities and Colleges of Canada and have their acceptance rescinded.

4.4 Application Fee

The application fee is currently \$70 CDN. This fee is paid to the university (not the department). Payment instructions can be found in the body of the application.

4.5 Program Fees (Tuition and Other Fees)

At Dalhousie, the graduate studies academic year (Sept.1 to Aug.31) is divided into three terms: Fall (September-December), Winter (January-April) and Summer (May-August). The total tuition and fees for one full year are due in three instalments, corresponding to the three terms.

Most graduate programs at Dalhousie University (including Mathematics & Statistics) have a minimum period for program fee payment and residency requirements. For example, a student admitted to a one-year, full-time Master's program is required to pay three consecutive terms of full-time program fees. The student may take two years to complete the MSc, but after the first year, the student will pay only continuing fees.

Students are expected to register for three consecutive terms unless otherwise given permission to take classes or undertake research elsewhere. If admitted to a two-year, full-time program, students are required to pay full-time program fees for 6 consecutive terms.

We normally admit PhD students into a two-year program, and expect them to complete their degrees in around four years. This means that for the first two years they pay full program fees and after that they pay continuing student fees until they graduate (see Table 1). There are no part-time PhD programs at Dalhousie.

Mathematics & Statistics degree programs are based on a program fee structure (e.g. a one-year program, two-year program etc.). Fees must be paid for all three terms in a given year, regardless of whether the student is taking courses in all three terms or how many courses are being taken in a particular term. So there are three payment due dates (in September, January and May). Exact dates can be found on the Graduate Studies website (<http://dalgrad.dal.ca/currentstudents/registrationandfees/>). Students who fail to register and pay tuition fees for any term before the degree program requirements have been fulfilled are considered to have withdrawn and will be

required to apply for re-admission. Re-admitted program fee students (except those who were withdrawn for academic reasons) must pay fees for the terms in which they were not registered, to a maximum of three terms at the current continuing fee rate.

Please visit Dalhousie's Student Accounts site (<http://www.dal.ca/studentaccounts>) for up-to-date information regarding tuition and fees. Table 1 in this document contains a breakdown of the most up-to-date program fees.

4.5.1 Differential Fees

Students registering at Dalhousie who are not Canadian citizens or permanent residents are required to pay an additional Differential Fee over and above the regular fees. This fee is applied to all graduate degrees in which the student registers, regardless of whether the student has already completed a Dalhousie graduate degree. Table 1 contains the exact amount. The fees are paid according to the following schedule:

Full-time Master's student: 2 years

Part-time Master's student: 6 years

2-year, full-time PhD student (following a Master's degree): 3 years

3-year, full-time PhD student (following a Bachelor's degree): 4 years

4.6 Residency Requirement

The minimum residency requirement by Dalhousie University is 1 year for the MSc and 2 years for the PhD program. This means that to obtain a degree the fees corresponding to the relevant length of time for each degree must have been paid to Dalhousie University.

PhD	MSc	FULL TIME FEES
\$7809	\$7473	Tuition
\$59	\$59	Student Union Fee
\$253	\$253	DSU Health and Dental Plan (1)
\$20	\$20	Society Fee
\$116.50	\$116.50	Student Service Fee
\$75	\$75	Facilities Renewal Fee
\$137.70	\$137.70	Bus Pass Fee
\$8,470.20	\$8,134.20	Total Canadian Student Fees
\$5190	\$5190	International Differential Fee (thesis based) (2)
\$636	\$636	International Student Health Insurance (1)
\$15	\$15	International Student Society Fee
\$14,311.20	\$13,975.2	Total International Student Fees
PhD	MSc	CONTINUING FEES
\$2046	\$2046	Tuition
\$59	\$59	Student Union Fee
\$253	\$253	DSU Health and Dental Plan (1)
\$20	\$20	Society Fee
\$116.50	\$116.50	Student Service Fee
\$75	\$75	Facilities Renewal Fee
\$137.70	\$137.70	Bus Pass Fee
\$2,707.20	\$2,707.20	Total Canadian Continuing Student Fees
\$3,358.20	\$3,358.20	Total International Continuing Student Fees
+ Applicable	+ Differential Fees (2)	

Table 1: Breakdown of 2011-2012 Tuition & Fees (pending approval)

(1) single rate, can be reimbursed if student has other coverage;

(2) payable for 2 years (MSc) or for 3 years (PhD), see section 4.7 of the graduate calendar.

Reference: http://www.dal.ca/admissions/money_matters/tuition_fees_costs/fee_schedules.html

5 Acceptance and Registration

5.1 Admission Decisions

Our first round of offers go out in late January and we continue making offers often into April. Our funds keep changing in that period as scholarship competition results are announced, and accordingly, we make new offers all the time. We ask you to please let us know if you are considering other offers and have not yet heard from us. Also, if you have an offer from our department and already know that you will be going elsewhere, we ask you to let us know at the earliest possible so we can admit a new student.

If you are coming to Dalhousie with your own external scholarships, your application can be considered at any time, as long as the proper deadlines (application, visa process, etc.) are met so that you can start the program on time.

5.2 Notification

When you are admitted into our graduate program, you will first receive a letter or email from the Department of Mathematics and Statistics, informing you that the department has recommended to the Dean of Graduate Studies that you be admitted (and possibly that you receive funding). It is important to know that this letter or email is not considered an “official” offer; it should be followed by an official admission letter from the Dean of Graduate Studies. In some cases, it is possible for the Dean not to accept the department’s recommendations. Please contact us if you do not receive your official admission letter in a timely manner, and particularly if you have alternative offers to consider from other universities.

You usually have one month to reply to the Dean’s admission letter and accept the offer of admission. If you do not reply by the deadline set out in the letter, your funding may be reallocated.

Once you have made a decision as to whether or not you will be accepting our offer, we request that you let the department know immediately. This helps us greatly in deciding how many students we can admit in a given year.

5.3 Admission Deposit

All students who have been accepted to start a graduate program from January 1, 2012 onward will be required to pay a \$200 non-refundable deposit. The deposit will reserve a place for the student in their program and will provide departments earlier confirmation of incoming students. The deposit will be credited towards the students tuition fees once they are registered. Please note, students will not be able to register until the deposit is paid.

Students will have 3 weeks from the day the acceptance letter is issued to pay the deposit through Student Accounts. If the deposit is not paid within one month a decision of “Offer Expired” will be put on their record.

5.4 Qualifying Year (MSc only)

A student applying for admission into the mathematics MSc program but with some deficiency in the particular discipline may be admitted to a Qualifying Year. Qualifying students are required to take specific courses that are chosen in consultation with the graduate coordinator. These courses are chosen from undergraduate classes or a mixture of undergraduate and graduate classes. Qualifying students can study full-time or part-time, and may be required to take as little as one half-credit (0.5) class or as many as ten one-half credit classes.

Qualifying-year students are not eligible for scholarship or bursary support and must apply for admission to the appropriate graduate program in the usual way towards the end of the qualifying period. Qualifying students must pass all classes taken as qualifying students with no grades below a B- and an average of at least B, and fulfil any other requirements in order to be considered for admission.

Students applying to the statistics program are unlikely to be admitted to a qualifying program. Strong preference is given to students who can be admitted directly into the program. Students wishing to improve their application through additional course work can take courses as special students (undergraduate); the undergraduate calendar should be consulted for additional information.

5.5 Special Student Graduate Studies

With permission of the Faculty of Graduate Studies, students are sometimes permitted to take a graduate class without being enrolled in a graduate program. The registration category for non-program students taking graduate classes is Special Student-Graduate Studies (SSGS). Such students, may normally take a maximum of two full-credit classes (four half classes) with the permission of the class instructor and the graduate coordinator. Because all graduate classes must be taught at a consistent standard to graduate level students, non-program students must have records which meet the minimum entrance requirements and follow the same application procedure as for a graduate program. Please see FGS regulations for details.

With permission granted from the FGS, it is possible to receive credit towards a graduate degree for courses completed under SSGS.

5.6 MSc With Option to Transfer to PhD

If you apply to our PhD program, you might be accepted into the Master's program with the option to transfer to the PhD program after one term. This means that you start the graduate program at Dalhousie in, say, September as an MSc student, and at the end of the Fall term, if your performance is deemed satisfactory by the department, transfer into the PhD program effective the Winter term (January). Once transferred, you may receive credit for the courses taken in the Fall term.

5.7 Admission Conditional on ESL

We often conditionally admit students into our graduate program who meet all the admissions criteria but have not satisfied the language requirements of Dalhousie University (Section 4.1). In such cases, the student will have a year to achieve the required scores on an ESL test, and can start the graduate program after that.

5.7.1 Where to Take ESL Courses

The College of Continuing Education (<http://collegeofcontinuinged.dal.ca/ESL/>) at Dalhousie University runs (English as a Second Language) ESL courses and administers the tests year-round. It is not required that you take the ESL courses here: you can use any program to obtain the required scores.

5.8 Deferral

Provided you instruct us in a timely manner, we can request a deferral of admittance for up to one year from the Dean of Graduate Studies; however, scholarships cannot be deferred.

5.9 Registration

Graduate students must maintain their registration in all three terms until their program is completed, except in those cases where a formal Leave of Absence has been officially approved by the Faculty of Graduate Studies. In addition to registering for classes, (usually done in September), students must add the Fee Generating Course (REGN 9999) for each term. In the Banner registration system, if REGN 9999 is not added for each term, graduate students are not considered registered. Failure to register properly, before the deadline, may result in nonpayment of scholarships and stipends. The deadline for the REGN registration is usually in the middle of August. Students should check the FGS website for the exact date. It is usually more convenient for students to register at this time for the entire year, if they anticipate continuing for an entire year.

All Students

All students must add the Fee Generating Course (REGN 9999) for each term.

	<u>Fall 2011</u>	<u>Winter 2012</u>	<u>Summer 2012</u>
REGN 9999	CRN 10902	CRN 20849	CRN 30068

First Year PhD Students

You should register for MATH 9520 every semester until you have passed your PhD comprehensive exams.

	<u>Fall 2011</u>	<u>Winter 2012</u>	<u>Summer 2012</u>
MATH 9520- Comprehensive Examinations	CRN 14605	CRN 24373	CRN TBD
STAT 9520- Comprehensive Examinations	CRN 14916	CRN 24650	CRN TBD

Continuing Students

Once you have completed all your courses (including MATH 9520 in the case of PhD students), you must register for your thesis. Course information is listed below

	<u>Fall 2011</u>	<u>Winter 2012</u>	<u>Summer 2012</u>
MATH 9000 - MSc Thesis	CRN 10200	CRN 20186	CRN 30164
MATH 9530 - PhD Thesis	CRN 10201	CRN 20187	CRN 30165
STAT 9000 - MSc Thesis	CRN 10773	CRN 20636	CRN 30182
STAT 9530 - PhD Thesis	CRN 10774	CRN 20637	CRN 30183

For registration details and deadlines, see Graduate Registration Information and Fees: (<http://dalgrad.dal.ca/currentstudents/registrationandfees/index.html>).

5.10 Student E-mail Address

The university issues an @dal.ca e-mail address to all students. This address is entered automatically in the Student Information System as the preferred e-mail address; it will be the address to which all general e-mail messages to students will be sent and it will be the address provided to faculty members when they request distribution lists for the sending of messages to students in their classes. A message sent by the university, or a faculty or staff member, to your @dal.ca address will be considered to have been delivered to you. You should visit (<http://www.dal.ca/ucis/services/email>) for detailed instructions on how to activate their @dal.ca account.

5.11 Dal Alert & Emergency Phone Text Messaging

Dal Alert (<https://dalalert.dal.ca/index.php>) is an integrated messaging service used to broadcast important information to the Dalhousie in events like campus hazard, significant campus closures, or other unpredictable events that might affect large groups. Dal Alert uses a variety of messaging media (e.g. email, text messaging, web, etc.) to reach a broad cross-section of the Dalhousie community in a timely fashion.

You can enter your Dalhousie ID and cell phone number to start receiving emergency alerts. A sign up window/tab has been added to the main page of MyDal (<https://my.dal.ca/cp/home/displaylogin>). This system is an additional but important tool to relay messages to students and employees in emergencies.

5.12 Notification of Address Change

All students must provide Dalhousie with a valid mailing address, and are responsible for keeping this information up-to-date. If your address changes, you must report your new address at Dalhousie Online (<http://www.dal.ca/online>). Notifications from the university will be sent to the most recent address on file, and failure to report a change of address is not a valid excuse for missing such notifications.

6 Arrival on Campus

6.1 Housing: Short and Long Term

There are affordable short-term and nightly accommodations available during the summer months at the Dalhousie residences. This is a good option to use when arriving on campus. Please see the website (<http://www.ancillaries.dal.ca/default.asp?mn=1.5.72>) for more information.

It can be difficult to find housing if you arrive on campus after classes start. The Residence Office (located at 1443 Seymour St.) has information on university accommodation and off-campus housing. Please view their website (<http://www.dal.ca/residence>) for further information.

A good local source of listings where you can find housing, used furniture and more, is the Kijiji Halifax website (<http://halifax.kijiji.ca/>).

6.2 Dalhousie ID Card (i.e. Student ID or BANNER No.)

On your arrival at Dalhousie (and assuming that you have registered online), one of your first priorities will be to obtain an ID card. New students may obtain their ID card at the Dalhousie Card Office located at 1443 Seymour St.

6.3 Departmental Facilities

The graduate secretary will assign each new student an office, a mailbox, a computer account and a code for the front door of the building.

There is a lounge and small kitchen with fridge and microwave on the second floor that is available to all graduate students and faculty for use. Please be respectful of the space and keep it clean and quiet so that everyone can enjoy this common area.

Rooms for seminars and meetings can be booked through the department office.

Photocopier accounts for students are charged to their supervisors. For accounts on the copy machine, please talk to the graduate secretary.

The Mathematics and Statistics Library is located in the basement (Room 008) of the Chase Building; see Section 6.6 for more details.

If you need to make on-campus phone calls, please go to the department office and ask one of the secretaries.

6.4 Departmental Computing Facilities

The department provides the following computing facilities to graduate students, faculty, staff and visitors in Chase Building:

- Office desktops with windows or linux as available options, if a computer is available;
- accounts that provide a department email address, storage space with tape backup and space on web server;
- two public heavy duty printers - one in the mail room and one in the basement;
- a 14 node Linux compute cluster for research computing;
- two sheet feed scanners and two public computers in room 001.

Here is some useful information on how to access the resources:

- ssh to (*chase.mathstat.dal.ca*) on port 44747 for access to email and storage space.
- Go to (<http://webmail.mathstat.dal.ca>) or (<http://mail.mathstat.dal.ca>) for webmail access.
- Go to (<http://www.mathstat.dal.ca/cluster>) for cluster documentation.

Additional options to access email from a standalone client from anywhere on the internet :

- Incoming Imap -
server - chase.mathstat.dal.ca, port - 993, Imap prefix - mail/, accept SSL certificate
- Outgoing smtp -
server - chase.mathstat.dal.ca, port - 587, use same username and password as imap, auth - plain, accept SSL certificate

Default disk quotas - all with daily tape backup - are the following:

250MB for inbox
250MB for home volume on chase
400MB at cluster

Extra storage space on chase/cluster with biweekly backup:

20GB on (/temp-1/<username>)

Extra storage space on chase/cluster with no backup:

5TB on (/scratch/<username>)

For any computing related questions in the Chase Building, please email Balagopal Pillai (pillai@mathstat.dal.ca).

6.5 Health and Dental Care

- **Nova Scotia MSI Card (Medical Services Insurance):**

The provincial medical insurance known as MSI is available to Nova Scotia residents at no charge and provides hospital and medical care free of charge. If you have been residing in Nova Scotia for 12 consecutive months and you have not left the province for more than 30 days at a time, you may be eligible for MSI. International Students who have secured positions as teaching or research assistants from a Dalhousie University department or faculty are eligible to apply for MSI immediately and do not have to wait the usual 12 months.

Please note that this is not an extended health coverage plan and prescription drugs, etc. are not covered. To obtain an application and determine your eligibility, please call the MSI office at 902-468-9700.

- **DSU Health and Dental Plan:** The Dalhousie Student Union Health and Dental Plan (<http://www.dsu.ca/inner.php?page=4&subI=92>) is required unless you have alternate coverage (proof required). You must apply to opt out of the plan. Visit their website for more information.

- **International Student Health Plan:** For international students the International Student Health Plan is mandatory if you are not eligible to apply for an MSI card. Please see (<http://ancillaries.dal.ca/default.asp?mn=1.1192.1193>) for more information on this plan. International Students who have secured positions as teaching or research assistants from a Dalhousie University department or faculty are eligible to apply for MSI immediately and do not have to wait the usual 12 months. Once you receive your MSI card, you can visit the International Student & Exchange Services office and inquire about opting out of the International Student Health Plan.

Dalhousie Health Services provides health care and services for students. Health Services is located at 6230 Coburg Rd. (corner of LeMarchant). Phone number is 494-2171. The Dalhousie Dental Clinic, which is an educational facility, offers a wide range of services to students. Patients accepted for treatment provide clinical experiences for dental students, and at the same time receive quality care at reduced fees. The clinic is located at 5981 University Ave. Phone number is 494-2101.

6.6 Libraries

All mathematics and statistics books are located in the Killam Library. The Killam Library is located across the parking lot behind the Chase Building. Your Dalhousie ID serves as a library card. This also entitles you to use other libraries on campus (e.g. Law or Medicine) or to borrow materials from other local university libraries. Library tours are available. Please consult the front desk at the Killam for further information.

The Graduate Students Centre on the fourth floor of Killam Library is a lounge dedicated to use by graduate students. It contains desks, conference rooms and facilities for study and discussions.

The Mathematics and Statistics Library is located in the basement (Room 008) of the Chase Building, the home of the Department of Mathematics & Statistics. The university public and public at large have access to the Reading Room from Monday to Friday during regular office hours (8am – 5pm), Summer hrs: (8am – 4pm). The library contains: most mathematics journals; about half of all Dalhousie statistics journals; a small reference section; mathematics, statistics and computing science theses written at Dalhousie; a computer terminal, primarily for access to internet library resources.

6.7 Bookstore

The university bookstore is located in the basement of the Student Union Building (6136 University Ave). Both new and used textbooks are available, though private sale of graduate texts is more common.

6.8 Student Employment Centre

The Dalhousie Student Employment Centre is on the 4th floor of the Student Union Building (SUB). A student may register full-time and hold a job simultaneously, only if the job involves no more than 16 hours of work per week, including a maximum of 10 hrs as a teaching assistant.

6.9 Student Accessibility & Accommodation

The Office of Student Accessibility & Accommodation, located next to the Killam Library on University Ave., administers the Accommodation Policy for Students: (<http://studentaccessibility.dal.ca/>)

Files/OSAA_Student_Policy.pdf).

This office is Dalhousie's centre of expertise for student accessibility and accommodation, based on a disability, religious or other issue. All requests for academic accommodation and non-academic accommodation made by registered students must be directed to this office. Please see their website for details and procedures: (<http://studentaccessibility.dal.ca/>). Prior to July 1, 2010, this Office was known as Student Accessibility Services.

6.10 Centre for Teaching & Learning

The Centre for Learning and Teaching (CLT) (<http://learningandteaching.dal.ca/>) works in partnership with academic units, faculty members, and graduate students to enhance the practice and scholarship of learning and teaching at Dalhousie University. CLT runs various workshops throughout the year, and offers support to teaching assistants. In particular, they annually hosts TA Professional Development Days, usually in mid-September.

6.11 Transportation and Parking

The University Bus Pass (U-Pass) is a special transit pass specifically designed for Dalhousie and King's students. If you're a full-time student, the U-Pass lets you ride Metro Transit buses, ferries and Community Transit buses from September to April. The U-Pass is a mandatory program for all full-time students. It costs \$118 per year and is automatically assessed in September with your incidental fees.

If you would like information on parking areas/permits, the Security Office is located in the basement parkade of the McCain Bldg. (across from the SUB). Forms must be completed in their office. If you would like information on bus passes, visit the Bookstore (basement of SUB).

6.12 University Closure/Cancellation of Classes

Any decision to close the university (e.g. for a severe snowstorm) is made in the President's Office and announced on Dalhousie's webpage (<http://www.dal.ca>) and on local CBC Radio 1 at 90.5 FM.

7 General Program Information

7.1 Seminars

Students are required to attend the departmental seminar series most relevant to their area of research, and are encouraged to attend the colloquia in their division. Students who are unable to attend seminars regularly must have the specific agreement of their supervisor or graduate coordinator that this requirement be waived.

Mathematics graduate students are required to give one talk a year in the Graduate Seminar Series (unless they speak in one of the departmental research seminars), on a subject relevant to their area of research, and regularly attend these seminars. This is a good opportunity to give a public talk in an informal environment.

7.2 Program Forms

Program Forms specify the course requirements for an MSc or PhD, and the composition of the supervisory committee. They are normally filled out during the first month of study, in consultation between the student and supervisor. The forms can be downloaded from the FGS website. The student signs the form and gives it to the graduate coordinator, who then submits it to the Program Officer at FGS, and distributes copies to the student and supervisor.

Once approved, the Program Form constitutes an agreement between the student and the university on the requirements to complete the program. Before graduation, FGS will review the student's Banner record and the Program Form for consistency. The student will not be able to graduate if there are discrepancies. It is the responsibility of the student to ensure consistency between the Banner records and the program form.

Students should only take classes listed on their Program Form. If they take additional classes, they will have to fill out a Program Update Form (see below) or may be required to pay additional fees.

7.3 Program Update Forms

The supervisor and FGS must be notified of any changes in a student's program requirements. These changes include changes in the length of the program, a change from full-time to part-time status, a change in course requirements, a change in supervisor, a change in the supervisory committee, or a change from MSc to PhD. FGS is notified of these changes through a Program Update Form. These forms can be downloaded from the FGS website, and must be signed by the student and graduate coordinator. The supervisor and student should receive the completed copies of these forms.

7.4 Progress Reports

Every graduate student is required to submit an Annual Progress Report to the Faculty of Graduate Studies, through their graduate coordinator. This report is due on an annual basis, one month prior to the anniversary of the student's admission date. Failure to submit this report may result in delays in registration and funding. Students who have external funding administered by the university are required to submit annual progress reports one month in advance of the one year anniversary of the start date of their award. This report will also satisfy the FGS progress report requirements. Forms available at (<http://www.dalgrad.dal.ca/currentstudents/forms/>).

7.5 AARMS Courses

The Atlantic Association for Research in the Mathematical Sciences (AARMS) runs a summer school every year. The school takes place at a university in Atlantic Canada. We quote from their website: “During a four week period every summer AARMS invites highly regarded faculty from around the world to deliver graduate courses in the mathematical sciences and their applications. Our goals are to broaden the education of graduate students and to encourage promising undergraduates to continue their study.”

Many of our students take courses at the AARMS summer school. We have two courses in Mathematics (MATH 5001, MATH 5002) and two in Statistics (STATS 5001, STATS 5002) at Dalhousie that you can sign up for to receive credit for the summer school. If you wish to take these courses for credit, please talk to the graduate coordinator in advance to have them approved.

We encourage our students to participate in these schools. For deadlines and all other details, please visit their website (<http://www.aarms.math.ca/summer/index.html>).

7.6 Taking Courses Outside Mathematics & Statistics

In special cases such as when the course requirements for a student cannot be satisfied with the current course offerings, the graduate coordinator may permit a student to take a course in a different department.

7.7 Taking Courses Outside Dalhousie

With the approval of the department and FGS, graduate students registered in a Master’s or PhD program may take courses for credit at another university provided the class is not available at Dalhousie. For the Graduate Student Letter of Permission form and guidelines please see (<http://dalgrad.dal.ca/currentstudents/forms/#lop>). Students may not take classes outside Dalhousie for graduate credit unless prior approval has been given by the Faculty. Classes are not approved retroactively.

The maximum number of classes taken outside Dalhousie University shall normally be confined to 33% of the class requirements except in cases where a university-level agreement, governing specific cooperative arrangements, has been negotiated and is in operation.

The normal regulations governing grading policy (FGS Regulation 6.6.2) apply to classes taken at other institutions (e.g., a C+ on a graduate class taken elsewhere will be deemed an “F” in the student’s program and may render him/her liable to academic withdrawal). Students who fail a class may not replace that class as Letter of Permission except by special permission from the Faculty of Graduate Studies.

Dalhousie will normally pay the tuition for students who pay a program fee to take classes offered at other Maritime universities, to the equivalent cost of a Dalhousie course, provided the class is not available at Dalhousie. Any course charges above that amount are the responsibility of the student. Students who are required to take classes at other institution outside the Maritimes will be considered on a case by case basis, e.g. if the class is a necessary component of a student’s program. The tuition for an approved class taken at a university outside the Maritimes is normally the responsibility of the student. Students who receive approval to take classes at institutions within or outside the Maritimes for convenience or for non-academic reasons do so at their own expense.

7.8 Transfer of Credit for Courses Taken Outside Dalhousie

With the approval of the graduate coordinator and the supervisor, a student may transfer up to 33% of their required credits from a different university. The appropriateness of the level and subject of each course shall be decided by the graduate coordinator, in consultation with the supervisor.

7.9 Reading Courses

By FGS regulations, students may not register for more than two reading courses and require written approval of their graduate coordinator to do so.

Procedure: each student will be provided with a class outline by the instructor. In order to complete the class satisfactorily, a student must fulfil all the requirements as set down in the class outline. By the end of the first week of class, the Independent Study / Directed Reading / Special Topics form (<http://dalgrad.dal.ca/currentstudents/forms/#directread>) must be submitted to the Faculty of Graduate Studies in order to be placed in the student's file. Changes to the outline which affect assessment components, the weight of individual assessment components, or examination requirements with a value of ten percent or more must have the approval of the enrolled student(s) in order to be valid and must also be sent to Faculty of Graduate Studies for the student file no later than four weeks after the beginning of the term in which the class is conducted.

When collaboration is included as part of class expectations as in group projects or group assignments, the instructor will provide in the class outline a statement of the degree of collaboration permitted in the preparation and submission of assignments.

7.10 Extensions

The normal upper time limits for an MSc are four years for full time students, and five years for part-time students. The time limit for a PhD student (always full-time) is six years.

A first extension of one year may be granted by the Faculty of Graduate Studies on the recommendation of the department, along with a satisfactory Progress Report form completed and signed by the student and the supervisor. Under no circumstances can a student be registered in a program for more than 10 years.

Requests for one further one-year extension, the final extension, must include a Progress Report form for the previous year together with a detailed plan and timetable for completion of the thesis within the following twelve (12) month period. The student is then expected to defend and submit the approved thesis within that academic year. A further extension will only be given for one term to provide for necessary revisions to the thesis following defence.

7.11 Grading Policy for Graduate Students

Under FGS regulations, all instructors of graduate classes (i.e., designated 5000 and above) at Dalhousie, with the exception of a few classes for which a pass/fail grading scheme has been approved, will use the following grading scheme:

Letter Grade	Numerical (%) Equivalent
A+	90-100
A	85-89
A-	80-84
B+	77-79
B	73-76
B-	70-72
F	< 70

Faculty of Graduate Studies regulations stipulate that graduate students must achieve a minimum, or passing, grade of "B-" in all classes. Any lower grade will be recorded as a failure. A student who fails to meet these requirements (in 3 credit hours) in any year is immediately and automatically withdrawn (academically dismissed) from the program. However, such a student may apply, in writing, to the department for immediate reinstatement, (see FGS regulations, Section 4.2.5, Re-admission of Students). Reinstatement to a program after a failing grade must be supported by the graduate coordinator, and must be approved in writing by the Faculty of Graduate Studies. If re-admitted, any subsequent "F" will result in a final program dismissal. Note that any academic withdrawal and reinstatement will be recorded on the student's official transcript.

7.12 FGS Travel Support

Students are encouraged to apply to FGS for travel support. It is normally given only for presentation of a poster or paper at scholarly meetings. Students are eligible for one travel grant during the period of their graduate degree program at Dalhousie, and should be presenting research related to their thesis. Students should consult the FGS handbook (<http://www.dalgrad.dal.ca/handbook/>) for more details.

7.13 Dalhousie Math & Stats Graduate Student Society

The Dalhousie Mathematics and Statistics Grad Society organizes the Graduate Seminar Series, and social events for Dalhousie Math and Stats grad students. Events in the past have included martini parties, bowling, game nights and boat cruises.

7.14 Guidelines for the Supervision of Graduate Students

The rights and responsibilities of students, supervisors, and the department are outlined in the FGS Calendar, and can be found at (<http://dalgrad.dal.ca/regulations/viii/#8.5>).

8 MSc Program Requirements

8.1 Curriculum Requirements

Students are normally required to complete six half-credits at the 5000 level or higher. Courses are expected to have some relevance to the student's research. The required courses are specified in the Program Form. Upon failure of any course (grade less than B-), a student will be withdrawn from the graduate program and must apply to the department for reinstatement. Reinstatement is at the discretion of the department and Faculty of Graduate Studies, following input from the supervisory committee. If a student fails two courses, re-admission is at the discretion of the Faculty of Graduate Studies and is highly unlikely.

8.2 MSc Supervisory Committee

The MSc supervisory committee consists of the supervisor plus one or more additional member, who must be a faculty member or adjunct. Co-supervisors count as members of the supervisory committee. The supervisory committee is specified in the Program Form and can be updated using a Program Update Form. The members of the supervisory committee is chosen by the supervisor, in consultation with the student and the graduate coordinator. Supervisory committees are encouraged to meet in advance of the defence to discuss research progress.

8.3 MSc Thesis

The MSc thesis should report on research by a student on a specific topic. The MSc thesis can contain original mathematical results, or it can be expository. The thesis must demonstrate the student's ability to read, understand and analyze the literature on a specific subject, add their own perspective, and synthesize their findings into a coherent presentation. It can include original observations in the form of computations, applications or discussions. Sometimes an MSc thesis results in a journal publication, and often it is a stepping stone to more in-depth research towards a PhD degree.

Students must familiarize themselves with the Thesis Format Guidelines available from the FGS website (<http://dalgrad.dal.ca/currentstudents/thesesanddefences/forms/>). The Thesis Format Guidelines are meant to ensure that high quality manuscripts are produced in a consistent style and that reproduction and reduction in size done by the National Library produce readable copies. The Mathematics Thesis LaTeX Template and deadlines are all available at the link above.

8.4 The MSc Examining Committee

The MSc examining committee normally consists of the supervisor, a second reader (or external), and chair (graduate coordinator or designate). The second reader must not have been involved with the supervision or direction of the thesis. The second reader is ordinarily chosen by the supervisor in consultation with the supervisory committee and the graduate coordinator. Below are the guidelines provided by FGS.

Each Master's thesis shall be examined by an examining committee, which shall consist of:

1. A chair, who shall be a department representative (either the graduate coordinator or designate) who was not a regular member of the supervisory committee. If the supervisory committee had an independent chair, that person may also chair the examining committee. The main role of the chair is to organize the examination of the thesis, inform the Faculty

Office of the membership of the examining committee, ensure that the procedures are carried out in an appropriate manner, record the examiners' written comments and the results of the examination for inclusion in the student's file, and inform the Faculty of the outcome of the examination;

2. The supervisory committee or at least two members of the graduate faculty appointed by the department at least one of whom shall have not been involved with the supervision or direction of the thesis;
3. Where the supervisory committee is part of the examining committee, at least one additional member of the graduate faculty shall be appointed who may be from the candidate's graduate program or department, but preferably should be from outside the involved program or department. The additional examiner must not have been involved with the supervision and direction of the thesis and must be in a position to render an objective and impartial assessment of the quality of the work. Where appropriate, the additional examiner may be from a graduate faculty of another university. With permission of the Dean, the additional examiner may be a non-faculty member (such as a practising professional who does not hold an Adjunct appointment with the Faculty) where it is deemed that they have the appropriate professional and academic qualifications and expertise to assess a graduate thesis. Departments may also use an external examiner in a manner similar to that used for the examination of Doctoral defences (i.e., the thesis cannot be approved without the agreement of the external examiner).
4. The Dean of Graduate Studies (or his/her designate) may appoint a Faculty representative if it is deemed necessary, or at the request of the student or the chair of the examining committee.

8.5 MSc Thesis Defence

The agreement of all supervisory committee members is normally required before a department brings forward a thesis for examination. Notice of an MSc thesis defence, including an abstract, is posted within the Mathematics & Statistics Department several days before the defence. A display copy of the thesis must be made available to the department office for faculty viewing. The MSc Thesis Defence format consists of a 20-25 minute talk by the student, several rounds of committee questions and audience questions. This is followed by private deliberation by the examination committee. The MSc Thesis Defence is open to the public. All theses are either approved or not approved. The categories are:

1. approved as submitted;
2. approved upon specific corrections being made (a clear timetable for completion of the revisions must be presented to the student, normally with a maximum of one month to complete the revisions);
3. rejected but with permission to re-submit a revised thesis for re-examination (a clear timetable for completion must be presented, normally with a maximum of one year to re-submit);
4. rejected outright.

In all cases, all members of the examining committee must submit written examination reports, dated and signed, which shall become part of the candidate's departmental file. The chair's written report shall summarize the outcome of the examination process, the final decision and any conditions attached. In the case of an outright failure or failure with a right to submit by a specific date, the graduate coordinator must send a written notification of failure to the Faculty.

8.6 MSc Thesis Timeline

Students should check the FGS website for the last dates on which they may submit finished theses to FGS for graduation in May (usually mid-April) or October (usually mid-September). Students are expected to distribute copies of their thesis to their examination committee at least **2 weeks** in advance of this date. This is intended to give members of the examination committee sufficient time to read the thesis, and for the student to undertake any minor changes to the thesis as recommended by the examination committee after the defence. It is the responsibility of the student to ensure that the MSc defence is held sufficiently in advance of the final FGS submission date to make any changes that might be required by the examination committee. Deadlines for the submission of the copies of the thesis to FGS in order to be eligible to graduate in May or October are final in all cases.

Intent to Graduate forms should be submitted to the Registrar's Office by late November, for May convocation and by late June for October convocation. Dates and forms are available on line from the Registrar's Office website at (<http://www.registrar.dal.ca>).

8.7 When to Submit Your Thesis

Your stipend will be discontinued at the end of the month in which your degree requirements are met and the final submission of your thesis is received in FGS, but the balance of the fees you paid for that term will not be refunded to you. Therefore, it would be wise to time the submission of your thesis appropriately. As one of our former students put it: "Don't hand in your thesis until the final month of your program."

8.8 Thesis Submission

FGS has moved to electronic submission of theses as PDF/A documents. Once submitted, the E-thesis is sent to the Dalhousie Institutional Repository (DalSpace) from which it is then harvested by Theses Canada, sent to the National Library, Ottawa and listed in Dissertation Abstracts International or Masters Abstracts International.

FGS does not coordinate thesis binding. Students interested in bound thesis copies can contact a binding company directly to make arrangements for binding of personal copies as needed. Supervisors and Departments will be able to access the thesis online via DalSpace, or can make arrangements with the student to obtain a bound copy.

For details on submitting PDF theses electronically please go to the website (<http://dalgrad.dal.ca/currentstudents/thesesanddefences/etheses/>)

9 PhD Program Requirements

9.1 Curriculum Requirements

Students are normally required to complete four half-credits at the 5000 level or higher. Courses are expected to have some relevance to the student's research. Supervisors have the right to require additional courses beyond these numbers. The required courses are specified in the Program Form. Upon failure of any course (grade less than B-), a student will be withdrawn from the graduate program and must apply to the department for reinstatement. Reinstatement is at the discretion of the department and Faculty of Graduate Studies, following input from the supervisory committee. If a student fails two courses, re-admission is at the discretion of the Faculty of Graduate Studies and is highly unlikely.

9.2 PhD Supervisory Committee

The PhD supervisory committee consists of the supervisor plus two or more additional members of the Faculty of Graduate Studies who are knowledgeable in the field of research. Co-supervisors count as members of the supervisory committee. The composition of the supervisory committee is chosen by the supervisor, in consultation with the student and the graduate coordinator. Members of the supervisory committee who are not co-supervisors normally act as examiners at both the internal and external thesis defence. Supervisory committees should meet during the thesis research period; FGS recommends at least twice a year.

9.3 Mathematics Comprehensive Examinations

As part of the Mathematics PhD program, each student must successfully pass three examinations. A PhD student must register for MATH 9520 (Comprehensive Examinations) each term until they have completed all three examinations and received a passing grade in the course. The three examinations cover material at an advanced level (equivalent to Dalhousie classes numbered 5000 or above). They are

1. An examination in the candidate's area of specialization;
2. Two other examinations to be chosen from the following list of non-specialty areas:
 - Algebra
 - Analysis
 - Combinatorics and Graph Theory
 - Differential Equations
 - Differential Geometry
 - Number Theory
 - Numerical Analysis
 - Probability
 - Statistics
 - Topology (General and Algebraic).

Syllabi for the Algebra and Analysis comprehensive examinations can be found in Section 10 of this handbook, and the others are available from the graduate secretary. For the specialty exam, a syllabus will be developed by the examining committee and approved by the graduate coordinator.

9.3.1 Rules

The rules of the comprehensive exams (some departmental, and some imposed by FGS guidelines) are as follows:

1. *There will be no overlap in the syllabus of any two of the comprehensive examinations a student takes.*
2. *At least one of the examinations must be in either Algebra or Analysis.*
 - **Core Courses:** Candidates may, in place of the non-specialty examination in Algebra, elect to register in, attend and write the final examinations in both of the courses MATH 5045 and MATH 5055 and achieve grades of B+ or better in those exams and/or in place of the non-specialty examination in Analysis elect to register in, attend and write the final examinations in two of the three courses MATH 5010, MATH 5020 and MATH 5540 (with approval of graduate coordinator) and achieve grades of B+ or better in those exams. Candidates wishing to avail themselves of this option must inform the graduate coordinator and the course instructors of this in at the beginning of the term in which they take the courses. The final examinations in these courses will be written, of 3 hours in length and will be marked by 2 faculty members. The exams will not be the same as those written in the cross listed courses MATH 4045 etc.
 - **Banking Comprehensive Examinations for MSc Students:** MSc students taking the core courses mentioned above are allowed to, with the permission of the graduate coordinator, take the corresponding comprehensive final exam for the course, and bank their passing grade so that it could be used once they are enrolled in the Mathematics PhD program at Dalhousie. This option is only available if there is no gap between the MSc and PhD programs for the student. MSc students wishing to avail themselves of this option must inform the graduate coordinator and the course instructors of this in at the beginning of the term in which they take the courses.

3. *The exams must be taken for the first time within 12 months and successfully completed within 16 months of registration in the program.*

Usually, the non-course-based exams are scheduled within a few days of each other, and typically at the end of the summer following a September start date (or December for a January start date).

4. *Comprehensive exams may only be taken after the completion of all required classwork.*

For this reason, all PhD students must complete their coursework in the first year.

9.3.2 Procedures

1. The candidate selects a specialty area and an advisor from this area, and obtains the advisor's consent. (Normally this advisor becomes the research supervisor.) The graduate coordinator should be informed as to whether or not this will be an oral examination.
2. The candidate and the advisor in consultation select the two non-specialty areas and inform the graduate coordinator of these areas.

3. The graduate coordinator, in consultation with the advisor and the candidate, appoints a comprehensive examination committee of two for each examination (normally including the advisor for the specialty examination), and obtains the consent of these committee members. Committee members should be Dalhousie faculty or adjunct professors.
4. It is the responsibility of the comprehensive examination committee to interpret the prepared syllabi. The candidate should consult with the appropriate examiners if clarification of the syllabus is required.
5. The graduate coordinator will schedule the examinations. Normally all three examinations will be held within one working week, unless some of them have been course-based (see above).
6. The official notification of the results of each examination will always come from the graduate coordinator.

9.3.3 Oral Examinations

Oral examinations are 60 to 90 minutes long, depending on their format. All oral examinations must be prepared in advance by the examination committee and submitted to the graduate coordinator. All members of the examining committee must be present at an oral examination. The graduate coordinator will assign an observer to an oral examination session who makes sure that the candidate, within the designated time-frame of the examination, has been given sufficient time to consider each question. Details of how each session is to proceed will be set ahead of time with the candidate, examination committee, observer and graduate coordinator. After the examination, a brief assessment of the candidate's performance by each member of the committee and signed by the observer will be filed with the graduate coordinator. Any repeated examination must be written.

9.3.4 Written Examinations

Written examinations are three hours in length. These examinations will be marked by the examination committee. Written examinations are marked by the examination committee and filed with the graduate coordinator. Any repeated examination must be written.

9.3.5 Non-specialty Examinations

These examinations must be written, and will emphasize general understanding rather than detailed technical knowledge. Syllabi as well as samples of past examinations are available from the graduate secretary. Students should consult the examining committee for each subject if they have questions about the syllabus.

9.3.6 Specialty Examinations

For the specialty examination, a syllabus will be developed by the examining committee and approved by the graduate coordinator.

A specialty exam can be written (3 hours) or oral (60 to 90 minutes, depending on the format).

9.3.7 Evaluation

The comprehensive examination committee will notify the graduate coordinator of its decision, in writing, that:

- (i) the candidate has passed the comprehensive examination; or
 - (ii) the candidate has failed the comprehensive examination; or
 - (iii) the candidate should repeat the comprehensive examination.
- A candidate who fails exactly one of the three examinations must be given the chance to repeat that examination.
 - A candidate who fails all three examinations will not be allowed to repeat the examinations and is no longer eligible to continue in the PhD program.
 - All repeated examinations must be written.
 - No examination may be repeated more than once.

9.3.8 Grievances

The candidate should bring any grievance or complaint regarding the implementation of their comprehensive examinations to the attention of the graduate coordinator as soon as any such matter arises. It is necessary that we have a transparent system for the examining committees as well as the candidate.

9.3.9 Practicing for Comprehensives

Old comprehensive exams are available at the department office. Please see the graduate secretary to receive copies.

9.4 Statistics Comprehensive Examinations

As part of PhD requirements, students must pass two 3 hour exams. Both are written on the same week in May of the year of admission. The first examination covers material on Statistical Inference and Linear Models. The second examination covers material on Probability and Multivariate Analysis. Student will be provided with a detailed syllabus for the examinations when they enter the program.

9.5 PhD Thesis

The PhD thesis should report original research of such value as to merit publication in a refereed scientific journal and be in a satisfactory and consistent form. Students must familiarize themselves with the Thesis Format Guidelines which are available from the FGS website (<http://dalgrad.dal.ca/currentstudents/thesesanddefences/forms/>). The Mathematics Thesis LaTeX Template is available at this link. The Thesis Format Guidelines, which allow for the incorporation of scholarly articles into the thesis, are meant to ensure that high quality manuscripts are produced in a consistent style and that reproduction and reduction in size done by the National Library produce readable copies. Students are strongly advised to show their thesis to the Thesis Clerk well in advance of final submission dates to ensure that there is enough time for any changes to be made.

9.6 The PhD Examining Committee

The examining committee consists of the research supervisor or co-supervisors, at least two additional members (who shall normally have been members of the supervisory committee), and the external examiner who shall be from outside the university. A departmental representative (the chairperson of the department or a designate) is included as a non-voting member of the committee.

9.7 PhD Internal Defence

The Department of Mathematics and Statistics requires that students publicly defend their thesis within the department before being allowed to submit their thesis to FGS. This defence consists of a 20 minute talk by the candidate followed by several rounds of questions by the examiners. Following questions by the examiners, questions by the public are considered. Immediately after the question period, a closed-room meeting with the examining committee results in one of the three recommendations

- (1) be permitted to submit the thesis to FGS,
- (2) be permitted to submit the thesis to FGS after specific changes,
- (3) be asked to make major changes to the thesis and resubmit to the internal examination committee at a later date.

When the internal defence is passed successfully, the internal examining committee signs the PhD Thesis Submission form http://dalgrad.dal.ca/docs/phd_thesis_submission.pdf and the PhD Examination Information form http://dalgrad.dal.ca/docs/PhD_Examination_Information_Form.pdf so that the candidate can submit them to FGS along with the final version of the thesis.

9.8 FGS Regulations Regarding PhD Examinations

The following regulations have been copied from Faculty of Graduate Studies Regulations and somewhat edited to fit our department's procedures.

9.8.1 Deadline for Graduation

For thesis students the published deadlines for the submission of the copies of the thesis to the Faculty Office in order to be eligible to graduate in May or October are final in all cases.

9.8.2 Regulations for the Defence of a Doctoral Thesis

All Doctoral theses must be examined in a public oral defence, to be conducted by an examining committee recommended by the department and approved by the Faculty of Graduate Studies. A candidate shall not be permitted to proceed with the oral defence and examination until all of the following requirements have been met:

- (i) all required classwork completed successfully;
- (ii) comprehensive examination passed;
- (iii) thesis title approved;
- (iv) examining committee established;

- (v) the style and format of the thesis meets the requirements of the university and appropriate copies of the thesis have been submitted as per regulations and deadlines in paragraphs 1-10 below.

Normally a candidate proceeds to oral defence with the approval of the supervisor and supervisory committee. A candidate may proceed without the consent of the supervisor and committee but a signed declaration included on the Thesis Submission Form is required by the Faculty.

9.8.3 Doctoral Defence Procedures

1. Registration of Thesis Title: The candidate shall register the proposed title of the thesis with the Faculty of Graduate Studies.
2. Appointment of external examiner: The Graduate Coordinator (where appropriate) shall recommend to the Associate Dean three names (with C.V.s) listed in order of preference as submitted by the thesis supervisor (and approved by the supervisory committee) for the appointment of an external examiner at least **three months** before the anticipated date of completion of the thesis. The persons suggested should be acknowledged experts in the field or discipline of the research being examined in the thesis, must not have been directly involved in the student's research in any way, and should possess a Doctoral degree or equivalent, and should normally have demonstrated experience of Doctoral supervision and/or examination. Brief C.V.s should be submitted along with the names. The choice of the external examiner must be approved by the Faculty of Graduate Studies. If the first choice is unacceptable to the Faculty or if that person is unavailable, then the other names will be considered in order of identified priority. The graduate coordinator may then confirm the availability of the external examination and proposed date and time for the defence. The formal invitation to the external examiner is issued by the Faculty (see para. 7. below).
3. Copies of Thesis Required for Examination: A minimum of **five** copies of the thesis are required, more if the examining committee is larger than the minimum Faculty requirements. The candidate shall submit one unbound copy of the completed thesis to the Faculty of Graduate Studies Office, together with the Thesis Submission Form and a C.V. The thesis will be given a preliminary check by the Faculty for formatting and style. The deadlines for submitting unbound PhD theses to departments (see the Schedule of Academic Dates in the Faculty of Graduate Studies calendar under August, November and February) are also the deadlines for submission of the one unbound copy (with completed PhD Thesis Submission Form) to the Faculty of Graduate Studies (see also para. 5. and 6. below). The copy is then sent to the external examiner by the Graduate Studies office once a date and time of defence is determined. At that time the candidate shall provide a copy of the abstract page from their thesis and a brief biographical sketch for publication in a public notice of the defence (this material must be submitted in Word compatible format and emailed to the Faculty Office).
4. Committee and Department Copies: The other four (or more as required) copies of the thesis will be submitted by the candidate to the departmental graduate coordinator, who will distribute them immediately to local members of the examining committee. One copy is held in the departmental secretary's office for use by other interested faculty and students.
5. No arrangements will be made for the oral examination until all these requirements are fulfilled. The examination will be held no earlier than four weeks after submission of the thesis, thereby allowing adequate time for the thesis to be read by the external examiner.

6. Time and Place: In consultation with the chairperson of the department, the graduate coordinator, and the research supervisor, the faculty will establish a time and place for the examination.
7. The Associate Dean of Graduate Studies will issue a formal invitation to the external examiner and will send a copy of the thesis (see para. 3 above) to him/her at least four weeks before the examination, with a request to submit a written appraisal (the Examiner's Report - see para. 8) of the thesis with a recommendation for the defence to either proceed or not proceed, no later than one week prior to the date of the defence.
8. The external examiner will submit by mail, fax, or email, a constructively critical and analytical report (the Examiner's Report) to the Faculty of Graduate Studies Office at least one week prior to the scheduled date of the defence. A copy will be sent to the department chair or graduate coordinator. The examiner's report must include a recommendation on whether or not the thesis should proceed to defence. Where the recommendation is not to proceed, the report should indicate what, if anything, would be required to make the thesis acceptable. Note that a decision to proceed to defence does not imply that the thesis is approved, only that it is acceptable for defence. The external examiner (and the examining committee) will have questions which must be answered to their satisfaction, and a thesis can be rejected as a result of the defence. The Examiner's Report must not be disclosed to the candidate or the supervisory committee prior to the defence (however, see para. 9. below). Normally the external examiner will attend the defence. The department will make every effort to arrange for alternative facilities (such as video- or teleconferencing) if they are appropriate to provide for the external examiner to participate in the defence even though he/she cannot be there in person. In the rare event of the external examiner not attending, a written report, accompanied by detailed questions to be read at the defence on the examiner's behalf should be submitted to the Faculty one week before the defence.
9. The defence will only occur if the external examiner states that the thesis may proceed. If the external examiner states that the thesis should not proceed, then the department chair or graduate coordinator may, after consultation with the supervisory committee, request that the Faculty approach the next external examiner from their original list to get a second opinion (the candidate may have to provide another copy of the thesis for this purpose). The Associate Dean of Graduate Studies may request additional suggestions for external examiners if necessary. If the second external does not feel the thesis should proceed to defence, then the entire defence procedure will be canceled and the candidate must meet with the supervisory committee to determine a course of action to revise and re-submit the thesis at a later date. Within 12 months, a revised and re-submitted thesis may be sent to the original external examiner(s) or an alternative examiner as deemed appropriate by the Faculty of Graduate Studies.
10. If the external examiner recommends that the thesis proceed to defence, notice of the public defence of the thesis will be published and sent to all relevant departments by the Faculty of Graduate Studies. All interested faculty, students, and members of the public will be welcome to attend.
11. Variation of the regulations outlined above may be permitted only with the written permission of the Dean of Graduate Studies.

9.8.4 Oral Examination

The oral examination of a Doctoral thesis is the culmination of the candidate's research program. It exposes the work to scholarly criticism and gives to the candidate the opportunity to defend the thesis in public.

1. **Chair of the Defence:** The examination is chaired by the Dean, the Associate Dean of Graduate Studies, or a member of the Panel of PhD Defence Chairs.
2. **Examining Committee:** The examining committee consists of the research supervisor or co-supervisors, at least two additional members (who shall normally have been members of the supervisory committee), and the external examiner who shall be from outside the university. A departmental representative (the chairperson of the department or a designate) is included as a non-voting member of the committee.
3. **Order of Examination Proceedings:**
 - (a) the chairperson opens the defence with a brief description of the proceedings;
 - (b) the candidate is questioned on the thesis following a summary presentation no longer than 20 minutes;
 - (c) the chairperson will give priority to questions from the external examiner and then from the other members of the examining committee in some pre-arranged order;
 - (d) the audience will then be invited to ask questions;
 - (e) the chairperson adjourns the examination when the examining committee decides that further questioning is unnecessary, and the candidate and all members of the audience are required to leave the room;
 - (f) the chair then presides over the examining committee during its deliberations in camera;
 - (g) following the in camera session, the candidate is invited back into the room and is informed of the decision of the committee;
 - (h) the chair oversees the completion of the signature sheet as appropriate and completes the Defence Report and returns it immediately to the Faculty of Graduate Studies Office.
 - (i) **In camera Deliberations and Grading:** The decision of the examining committee is based both on the thesis and on the candidate's ability to defend it. No thesis shall be approved without the agreement of an external examiner, except that a negative opinion of an external examiner who does not attend the examination should not prevail over the unanimous opinion of the other examiners present and voting. The thesis is graded "approved" or "not approved". A thesis can be accepted by the examining committee as submitted; accepted on condition that specific corrections are made; rejected with permission to submit a revised thesis; or rejected outright with no possibility of re-submission. It should be stressed that theses can be rejected on grounds of form as well as content. If specific corrections are required, the thesis will be returned to the candidate and a time limit during which the corrections must be completed will be decided upon by the examining committee. Specific corrections will normally be left to the satisfaction of the local committee and research supervisor.

4. **Proceedings in the Case of Rejection:** If the thesis is rejected with permission to submit a revised thesis (within 12 months of the first defence), the revised thesis will be re-read by an examining committee, at least two of whose members were on the original committee. The thesis shall be submitted to an external examiner who may be the original external examiner if the Associate Dean of Graduate Studies considers this to be desirable. The candidate shall defend the thesis before an examining committee in the usual way. If rejected again, there are no third chances.
5. In all cases, the recommendation for degree must be approved by the Faculty of Graduate Studies and by the senate.
6. Variation of the procedures stipulated above may be permitted only with the written permission of the Dean of Graduate Studies.

9.9 PhD Defence Timeline

The time-line is usually dictated by the date at which the candidate must submit the completed version of the thesis to graduate in May or October. The timeline below is based on the assumption that any changes to the thesis recommended after the Internal and FGS defences are minor. It is the responsibility of the student to initiate the defence process sufficiently in advance of all deadlines to ensure sufficient time for changes to the thesis to be made. The timeline below is intended to complement the PhD timeline given on the FGS web site (<http://dalgrad.dal.ca/currentstudents/thesesanddefences/checklists/>).

1. *6 months in advance of the FGS Defence:* The candidate registers the thesis title with FGS. Consult the FGS calendar for the exact date.
2. *3 Months in Advance of the FGS Defence:* Supervisors should supply the graduate coordinator with the names of at least three potential external examiners. The graduate coordinator requires this information to submit the Request to Arrange Oral Defence of a Doctoral Thesis form. The supervisor should confirm with the recommended external examiner that he/she is willing to participate in the FGS Defence prior to giving this list to the graduate coordinator. The other two names on the list are to be used only if the recommended external examiner is not available, and do not need to be contacted. External examiners should have a PhD, hold an appointment at a university that grants PhD degrees, and have experience examining and supervising PhD students. To ensure arms length status, they should not be employed in Nova Scotia, not have a degree from Dalhousie, not have been involved with the student's research, and not have co-published with the supervisor. More detailed information on the qualifications of external examiners is given in the Request to Arrange Oral Defence of a Doctoral Thesis form.
3. *10 Weeks Before Submission of the Thesis to FGS:* The candidate must submit an Intent to Graduate Form (see the FGS calendar for the exact date).
4. *7 Weeks prior to FGS Defence and 2 weeks prior to Internal Defence:* the candidate distributes copies of the thesis to the supervisory committee plus graduate coordinator and the departmental office for faculty viewing.
5. *At least 5 weeks prior to the FGS Defence:* Internal Defence.

6. *At least 4 weeks prior to FGS Defence:* The candidate submits copies of the thesis (approved by the department) to FGS for distribution to the external examiner. The candidate also distributes copies of the thesis to the rest of the examination committee. The candidate should consult the FGS calendar for the last date at which this can be done in order to graduate in May or October, or to not have to register for the winter term. The candidate must ensure that there is sufficient time between the Internal Defence and the date for final submission to FGS to make any revisions requested by the supervisory committee after the Internal Defence.
7. *At least 4 weeks before the FGS Defence:* The graduate coordinator submits a PhD Examination Information to FGS.
8. *10 Days prior to the Date for last day of Submission of Thesis to FGS for May/October Graduation:* This is the last day to conduct the FGS Defence. This is intended to allow sufficient time for minor corrections of the thesis to be made. university.

9.10 When to Submit Your Thesis

Please see Section 8.7.

9.11 Thesis Submission

Please see Section 8.8.

10 Algebra and Analysis Comprehensive Exams

10.1 Syllabus for Non-specialist Comprehensive Exam in Algebra

(Updated: January 2007)

To pass the non-specialist examination in Algebra, a student has to pass **both of the following options**. Please note that each of these topics correspond to the syllabus of a course that is listed next to it. To pass the examination in each subject, the student may choose to pass the corresponding course, following procedures outlined in the Graduate Handbook.

Abstract Algebra I (MATH 5045)

Topics

1. Rings up to and including unique factorization and irreducibility for polynomial rings.
(Chapters 7, 8, 9.1-9.5 of *Dummit & Foote*)
2. Modules, including the structure theorem for finitely generated modules over a PID, and linear algebra.
(Chapters 10.1 – 10.4, 12 of *Dummit & Foote*)

Abstract Algebra II (MATH 5055)

Topics

1. Groups up to and including Sylow Theorems.
(Chapters 1, 2, 3, 4, 5.1–5.3 of *Dummit & Foote*)
2. Galois Theory.
(Chapters 13, 14 of *Dummit & Foote*)

Suggested References

- Artin, E. *Galois Theory*, Notre Dame (QA171 A79)
- Dummit, D. & Foote, R. *Abstract Algebra*, Prentice Hall (QA162 D85)
- Jacobson, N. *Basic Algebra I*, Freeman (QA154.2 J32)
- Lang, S. *Algebra*, Addison Wesley (QA154 L27)

10.2 Syllabus for Non-specialist Comprehensive Exam in Analysis

(Updated: January 2011)

To pass the non-specialist examination in Analysis, a student has to pass **TWO out of the following three options**. The exact combination of the three options that can be used to satisfy comprehensive requirements should be decided by the grad coordinator in consultation with the student and supervisor. Please note that each of these topics correspond to the syllabus of a course that is listed next to it. To pass the examination in each subject, the student may choose to pass the corresponding course, following procedures outlined in the Graduate Handbook.

Real Analysis (MATH 5010)

Topics

1. Measure spaces: σ -algebras; measures; measurable functions.
2. Construction of measures: *either* locally compact Hausdorff spaces and the Riesz representation theorem, *or* outer measures and Carathéodory's theorem; construction of Borel measures on the real line; Lebesgue measure on the real line.
3. Lebesgue Integration: integrals of real- and complex-valued functions; monotone and dominated convergence theorems; product measures, Fubini and Tonelli theorems; Lebesgue integral in \mathbb{R}^n .
4. Signed Measures: Lebesgue-Radon-Nikodym theorem.
5. Elementary Banach space theory; L^p , L^∞ spaces; Hölder's and Minkowski's inequalities; completeness; relations between L^p spaces; duality and L^p spaces.

Suggested References

- G. B. Folland, *Real Analysis: Modern Techniques and their Applications*, John Wiley, 2nd ed., 1999.
- H. L. Royden, *Real Analysis*, Prentice Hall, 3rd ed., 1988.
- W. Rudin, *Real and Complex Analysis*, McGraw-Hill Science/Engineering/Math; 3rd ed., 1986.

Complex Analysis (MATH 5020)

Topics

1. Holomorphic functions: Cauchy and Morera theorems.
2. Residues, contour integration including branch cuts.
3. Liouville's theorem, maximum modulus principle, Schwartz lemma.
4. Rouché's theorem, argument principle.
5. Conformal mapping, Möbius transformations, Riemann Mapping theorem, applications.

Suggested References

- L. V. Ahlfors, *Complex Analysis*, McGraw-Hill Education, 1980.
- J. B. Conway, *Functions of One Complex Variable*, Springer-Verlag, 2002.
- J. E. Marsden, *Basic Complex Analysis*, W. H. Freeman & Company, 3rd ed., 1998.
- W. Rudin, *Real and Complex Analysis*, McGraw-Hill Science/Engineering/Math; 3rd ed., 1986.

Applied Analysis (MATH 5540)**Topics**

1. Fourier series: Orthogonality, Dirichlet kernel, Completeness, Gibb's phenomenon, Fourier transform.
2. Tensor calculus: Change of basis, the metric tensor, covariant differentiation, vector operators, geodesics.
3. Calculus of variations: Euler-Lagrange equation, Hamilton's principle, constrained variation.

Suggested References

- K. F. Riley, M. P. Hobson and S. J. Bence, *Mathematical methods for physics and engineering*, Cambridge University Press; 3rd ed., 2006.
- (For Fourier series) W. Strauss, *Partial differential equations, an introduction*, Wiley, 2nd ed., 2007.