Graduate Studies
in Mathematics
2013-14
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INTRODUCTION

The purpose of this handbook is to provide information about the graduate programs of the Department of Mathematics, University of Toronto. It includes detailed information about the department, its faculty members and students, a listing of core courses offered in 2013-2014, a summary of research activities, admissions requirements, application procedures, fees and financial assistance, and information about similar matters of concern to graduate students and prospective graduate students in mathematics.

This handbook is intended to complement the calendar of the university’s School of Graduate Studies, where full details on fees and general graduate studies regulations may be found.

For further information, please contact:

The Graduate Office
Department of Mathematics
University of Toronto
40 St George St, Room 6166
Toronto, Ontario, Canada M5S 2E4
Telephone: (416) 978-7894
Fax: (416) 978-4107
Email: grad-info@math.toronto.edu
Website: http://www.math.utoronto.ca/cms/graduate-program/

1. DEPARTMENT OF MATHEMATICS

Mathematics has been taught at the University of Toronto since 1827. Since the first Canadian Ph.D. degree in mathematics was conferred to Samuel Beatty (under the supervision of John Charles Fields) in 1915, more than 400 Ph.D. degrees and 1000 Master’s degrees have been awarded in this University. Many of our recent graduates are engaged in university teaching and a significant number of them hold administrative positions in universities or in the professional communities. Others are pursuing careers in industry (technological or financial), or in government.

The Department of Mathematics, University of Toronto is a distinguished faculty of more than sixty mathematicians. We have a large selection of graduate courses and seminars, and a diverse student body of domestic and international students, yet classes are small and the ratio of graduate students to faculty is low. We are in a unique position to take maximum advantage of the presence of the Fields Institute, which features special programs in pure and applied mathematics. Currently the department has 124 graduate students, of whom 24 are enrolled in the Master’s program, 93 in the Ph.D. program, 4 in non-degree programs, and 3 international visiting research graduate students.
Opportunities for graduate study and research are available in most of the main fields of pure and applied mathematics. These fields include real and complex analysis, ordinary and partial differential equations, harmonic analysis, nonlinear analysis, several complex variables, functional analysis, operator theory, $C^*$-algebras, ergodic theory, group theory, analytic and algebraic number theory, Lie groups and Lie algebras, automorphic forms, commutative algebra, algebraic geometry, singularity theory, differential geometry, symplectic geometry, classical synthetic geometry, algebraic topology, set theory, set theoretic topology, mathematical physics, fluid mechanics, probability (in cooperation with the Department of Statistics), combinatorics, optimization, control theory, dynamical systems, computer algebra, cryptography, and mathematical finance.

We offer a research-oriented Ph.D., and Master’s program. Very strong students may be admitted directly to the Ph.D. program with a Bachelor’s degree; otherwise; it is normal to do a 1-year Master’s degree first. (Provisional admission to the Ph.D. program may be granted at the time of admission to the Master’s program.) The Master’s program may be extended to 16 months or 24 months for students who do not have a complete undergraduate preparation, or for industrial students engaged in a project.

There is a separate Master’s of Mathematical Finance Program not directly under the Department’s jurisdiction, but with which some of our faculty members are associated.

During their studies here, graduate students are encouraged to participate in the life of the close community of U of T mathematics. Almost all of them do some work in connection with undergraduate teaching, either as tutorial leaders, markers, or, especially in later years of their program, instructors. There is a Mathematics Graduate Student Association, which organizes social and academic events and makes students feel welcome.
GRADUATE FACULTY MEMBERS

AKCOGLU, M.A. (Professor Emeritus) Ph.D. 1963 (Brown)
  • Ergodic theory, functional analysis, harmonic analysis
ALEXAKIS, Spyros (Assistant Professor) Ph.D. 2005 (Princeton)
  • Geometric analysis and general relativity
ARTHUR, J. (University Professor, Mossman Chair) B.Sc. 1966 (Toronto), M.Sc. 1967 (Toronto), Ph.D. 1970 (Yale)
  • Representations of Lie groups, automorphic forms
BARBEAU, E. (Professor Emeritus) B.Sc. 1960 (Toronto), M.A. 1961 (Toronto), Ph.D. 1964 (Newcastle)
  • Functional analysis, optimization under constraint, history of analysis, number theory
  • Theory of quantum invariants of knots, links and three manifolds
BIERSTONE, E. (Professor) B.Sc. 1969 (Toronto), Ph.D. 1973 (Brandeis)
  • Singularity theory, analytic geometry, differential analysis
BINDER, I. (Associate Professor) Ph.D. 1997 (Caltech)
  • Harmonic and complex analysis, conformal dynamics
BLAND, J. (Professor) Ph.D. 1982 (UCLA)
  • Several complex variables, differential geometry
BLOOM, T. (Professor Emeritus) Ph.D. 1965 (Princeton)
  • Several complex variables
BUCHWEITZ, R.-O. (Professor) Ph.D. (Dr.rer.nat.) 1976 (Hannover), Doctorat d’Etat 1981 (Paris VII)
  • Commutative algebra, algebraic geometry, singularities
BURCHARD, A. (Professor) Ph.D. (Georgia Tech) 1994
  • Functional analysis
CHOI, M.-D. (Professor Emeritus) M.Sc. 1970 (Toronto), Ph.D. 1973 (Toronto)
  • Operator theory, operator algebras, matrix theory
COLLIANDER, James (Professor) Ph.D. 1997 (Illinois, Urbana-Champaign)
  • Partial differential equations, harmonic analysis
  • Operators on Hilbert spaces, matrix theory and applications (including numerical analysis)
DEL JUNCO, A. (Professor) B.Sc. 1970 (Toronto), M.Sc. 1971 (Toronto), Ph.D. 1974 (Toronto)
  • Ergodic theory, functional analysis
DERZKO, N. (Associate Professor Emeritus) B.Sc. 1970 (Toronto), Ph.D. 1965 (Caltech)
  • Functional analysis, structure of differential operators, optimization and control theory with applications to economics
ELLERS, E. (Professor Emeritus) Dr.rer.nat. 1959 (Hamburg)
  • Classical groups
ELLIOTT, G. A. (Canada Research Chair and Professor) Ph.D. 1969 (Toronto)
  • Operator algebras, K-theory, non-commutative geometry and topology
FRIEDLANDER, J. (University Professor) B.Sc. 1965 (Toronto), Ph.D. 1972 (Penn State)
  • Analytic number theory
  • Spectral theory of Schroedinger operators and localization
GRAHAM, I. (Professor) B.Sc. 1970 (Toronto), Ph.D. 1973 (Princeton)
• Several complex variables, one complex variable
GREINER, P.C. (Professor Emeritus) Ph.D. 1964 (Yale)
• Partial differential equations
GUALTIERI, M. (Associate Professor) Ph.D. 2003 (Oxford)
• Differential geometry and mathematical physics
HALPERIN, S. (Professor Emeritus) B.Sc. 1965 (Toronto), M.Sc. 1966 (Toronto), Ph.D. 1970 (Cornell)
• Homotopy theory and loop space homology
HERZIG, F. (Assistant Professor) PhD 2006 (Harvard)
• Number theory, Galois representations, automorphic forms
IVRII, V. (Professor) Ph.D. 1973 (Novosibirsk)
• Partial differential equations
JEFFREY, L. (Professor) Ph.D. 1992 (Oxford)
• Symplectic geometry, geometric applications of quantum field theory
JERRARD, Robert (Professor) Ph.D. 1994 (Berkeley)
• Nonlinear partial differential equations, Ginzburg-Landau theory
JURDJEVIC, V. (Professor Emeritus) Ph.D. 1969 (Case Western)
• Systems of ordinary differential equations, control theory, global analysis
KAMNITZER, Joel (Associate Professor) Ph.D. 2005 (Berkeley)
• Geometric and combinatorial representation theory
KAPOVITCH, V. (Associate Professor) Ph.D. 1997 (University of Maryland)
• Global riemannian geometry
KARSHON, Y. (Professor) Ph.D. 1993 (Harvard)
• Equivariant symplectic geometry
KHANIN, K. (Professor) Ph.D. 1983 (Landau Institute, Moscow)
• Dynamical systems and statistical mechanics
KHESIN, B. (Professor) Ph.D. 1989 (Moscow State)
• Poisson geometry, integrable systems, topological hydrodynamics
KHOVANSKII, A. (Professor) Ph.D. 1973, Doctorat d’Etat 1987 (Steklov Institute, Moscow)
• Algebra, geometry, theory of singularities
KIM, Henry (Professor) Ph.D. 1992 (Chicago)
• Automorphic L-functions, Langlands’ program
KUDLA, S. (Canada Research Chair and Professor) Ph.D. 1971 (Harvard)
• Automorphic forms, Arithmetic geometry and Theta functions
LORIMER, J.W. (Professor Emeritus) Ph.D. 1971 (McMaster)
• Rings and geometries, topological Klingenberg planes, topological chain rings
McCANN, R. (Professor) Ph.D. 1994 (Princeton)
• Mathematical physics, mathematical economics, inequalities, optimization, partial differential equations
McCOOL, J. (Professor Emeritus) Ph.D. 1966 (Glasgow)
• Infinite group theory
MEINRENKEN, E. (Professor) Ph.D. 1994 (Universität Freiburg)
• Symplectic geometry
MENDELSOHN, E. (Professor Emeritus) Ph.D. 1968 (McGill)
• Block designs, combinatorial structures
MILMAN, P. (Professor) Ph.D. 1975 (Tel Aviv)
• Singularity theory, analytic geometry, differential analysis
MURASUGI, K. (Professor Emeritus) D.Sc. 1960 (Tokyo)
• Knot theory
MURNAGHAN, F. (Professor) Ph.D. 1987 (Chicago)
• Harmonic analysis and representations of p-adic groups
• Number theory
NABUTOVSKY, A. (Professor) Ph.D. 1992 (Weizmann Institute of Science)
• Geometry and logic
NACHMAN, A. (Professor) Ph.D. 1980 (Princeton)
• Inverse problems, partial differential equations, medical imaging
PUGH, M. (Associate Professor) Ph.D. 1993 (Chicago)
• Scientific computing, nonlinear PDEs, fluid dynamics, computational neuroscience
QUASTEL, J. (Professor) Ph.D. 1990 (Courant Institute)
• Probability, stochastic processes, partial differential equations
RAFI, Kasra (Assistant Professor) Ph.D. 2001 (Stony Brook)
• Teichmüller space, geometric group theory, hyperbolic geometry
REPKA, J. (Professor) B.Sc. 1971 (Toronto), Ph.D. 1975 (Yale)
• Group representations, automorphic forms
ROONEY, P.G. (Professor Emeritus) Ph.D. 1952 (Caltech)
• Integral operators, functional analysis
ROSENTHAL, P. (Professor Emeritus) Ph.D. 1967 (Michigan)
• Operators on Hilbert spaces
ROTMAN, R. (Professor) Ph.D. 1998 (SUNY, Stony Brook)
• Riemannian geometry
SCHERK, J. (Associate Professor) D.Phil. 1978 (Oxford)
• Algebraic geometry
SECO, L. (Professor) Ph.D. 1989 (Princeton)
• Harmonic analysis, mathematical physics, mathematical finance
SELICK, P. (Professor) B.Sc. 1972 (Toronto), M.Sc. 1973 (Toronto), Ph.D. 1977 (Princeton)
• Algebraic topology
SEN, D.K. (Professor Emeritus) Dr.es.Sc. 1958 (Paris)
• Relativity and gravitation, mathematical physics
SHARPE, R. (Professor Emeritus) B.Sc. 1965 (Toronto), M.Sc. 1966 (Toronto), Ph.D. 1970 (Yale)
• Differential geometry, topology of manifolds
SHERK, F.A. (Professor Emeritus) Ph.D. 1957 (Toronto)
• Finite and discrete geometry
SIGAL, I.M. (University Professor, Norman Stuart Robertson Chair in Applied Math) Ph.D. 1975 (Tel Aviv)
• Mathematical physics
• Fluid mechanics, particularly boundary layer theory
• Partial differential equations, nonlinear analysis, numerical computations in fluid dynamics
SZEGEDY, B. (Assistant Professor) Ph.D. 2002 (Eötvös University, Budapest)
• Group theory, Combinatorics, Computer science
TALL, F.D. (Professor Emeritus) Ph.D. 1969 (Wisconsin)
- Set theory and its applications, set-theoretic topology
TANNY, S.M. (Associate Professor) Ph.D. 1973 (M.I.T.)
- Combinatorics, mathematical modeling in the social sciences
TODORCEVIC, S. (Canada Research Chair and Professor) Ph.D. 1979 (Belgrade)
- Set theory and combinatorics
VIRAG, B. (Canada Research Chair and Professor) Ph.D. 2000 (Berkeley)
- Probability
WEISS, W. (Professor) M.Sc. 1972 (Toronto), Ph.D. 1975 (Toronto)
- Set theory, set-theoretic topology
YAMPOLSKY, M. (Professor) Ph.D. 1997 (SUNY, Stony Brook)
- Holomorphic and low-dimensional dynamical systems
YOUNG, R. (Assistant Professor) PhD 2007 (Chicago)
- Geometric group theory, non-positive curvature, mathematical biology
ZHANG, Ke (Assistant Professor) PhD 2007 (Pennsylvania State University)
- Dynamical systems: Hamiltonian dynamics, weak KAM theory, Arnold diffusion, smooth dynamics.

2. THE GRADUATE PROGRAM

The Department of Mathematics offers graduate programs leading to Master of Science (M.Sc.) and Doctor of Philosophy (Ph.D.) degrees in mathematics, in the fields of pure mathematics and applied mathematics. Students admitted to our M.Sc. program are admitted either as “terminal master’s” students or as “doctoral stream” students, the latter implying the intent of continuing on to our Ph.D. program. Students admitted to the doctoral-stream master’s program are fully funded for one year at the master’s level. Funding is limited to four years at the PhD level.

The M.Sc. Program

The M.Sc. program may be done on either a full- or part-time basis. Full-time students normally complete the program in one full year of study; part-time students may take up to three years to complete the program. The degree requirements are as follows:

1a. Completion of 6 half-courses (or the equivalent combination of half- and full-year courses). A current listing is available from the mathematics department website. The normal course load for full-time graduate students is 3 courses in the fall term and 3 in the spring term. Doctoral-stream students are required to take four half-course credits in core material.

1b. Completion of the Supervised Research Project (MAT 4000Y). This project is intended to give the student the experience of independent study in some area of advanced mathematics, under the supervision of a faculty member. The supervisor and the student, with the approval of the graduate coordinator decide the topic and program of study. The project is normally undertaken during the summer session, after the other course requirements have been completed, and has a workload roughly equivalent to that of a full-year course.

2. M.Sc. Thesis Option (less common than option 1). Students who take this option will be required to take and pass four half-courses and submit an acceptable thesis. A presentation of the thesis results, in the form of a seminar, is required.
The Ph.D. Program

The Ph.D. program normally takes three or four years of full-time study beyond the Master’s level to complete. A Master’s degree is normally a prerequisite; however, exceptionally strong B.Sc. students may apply for direct admission to the Ph.D. program. Expected progress in the program is outlined in the following table:

<table>
<thead>
<tr>
<th>Year 1</th>
<th>Completion of course work; Pass at least 3 comprehensive exams; Select a thesis advisor.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2</td>
<td>Supervisory committee selected by graduate coordinator; First annual supervisory committee progress report due.</td>
</tr>
<tr>
<td>Year 3</td>
<td>Presentation of preliminary thesis results to supervisory committee.</td>
</tr>
<tr>
<td>Year 4</td>
<td>Thesis Content Seminar; Departmental PhD Thesis Examination; Final PhD Thesis Examination at the School of Graduate Studies.</td>
</tr>
<tr>
<td>Year 4 – October</td>
<td>Students interested in academic employment after the PhD must have major thesis results ready.</td>
</tr>
</tbody>
</table>

1. **Coursework:** Completion of at least 6 half-courses (or the equivalent combination of half- and full-year courses) A current listing is available from the mathematics department website. Normally, 6 half-courses are taken in the first year of study (3 half-courses in the fall term and 3 in the spring term). It is strongly recommended that the student take some additional courses in other years.

2. **Comprehensive Examination:** The student is required to pass at least three comprehensive examinations in basic mathematics before beginning an area of specialization. The examinations in the four general areas (analysis (real and complex), algebra, topology and partial differential equations) take place during a one-week period in early September. The passing grade on these examinations is A-/80%. Exemptions from individual exams will be given if the student has obtained a grade of A- or better in the corresponding core course(s). Syllabi for the pure mathematics comprehensive exams appear in Appendix A. Copies of mock examination questions and/or past written examination papers are accessible to all candidates at [http://www.math.toronto.edu/graduate/pce](http://www.math.toronto.edu/graduate/pce).

Students with interests in applied mathematics should refer to Appendix B for possible alternate comprehensive exams.

All exams are to be taken within 13 months of entering the Ph.D. program unless the Examination Committee grants permission in writing for a deferral.

3. **Supervisory Committee:** The purpose of the Supervisory Committee (SC) is to monitor the student’s progress at least on an annual basis, keeping the following in mind.

No supervisor is perfect! The SC may be able to offer further mathematical and further career advice beyond what the supervisor alone may offer. This is relevant both at the start of studies, when mathematical advice is most in need, and towards the end of studies, when career advice is needed.
No student is perfect! The SC should note if a student is falling behind and should propose ways for the student to catch up, if necessary.

While most student-supervisor relationships are cordial and productive, occasional misunderstandings, miscommunications and cases of false expectations do occur. The SC should note if a student-supervisor relationship is heading wrong and make sure that steps are taken to fix the problems.

Ph.D. students must select a supervisor by the beginning of their second year in the Ph.D. program. In accordance with School of Graduate Studies regulations, a supervisory committee (SC) will be established for each Ph.D. student who has chosen a research area and a supervisor. This committee consists of three faculty members including the supervisor. The SC is expected to meet with the student at least annually, including on the last year of studies. Since some of the role of the SC is private and confidential, it is not appropriate to substitute these meetings with public lectures. The SC will file an annual written report with the graduate office.

Further information about general graduate supervision is available at http://www.sgs.utoronto.ca/Assets/SGS+Digital+Assets/admin+support/Supervision+Guidelines.pdf

4. Thesis: The main requirement of the degree is an acceptable thesis. This will embody an individual contribution to original research of a standard that warrants publication in the research literature. It must be written under the supervision of one or more members of the department. The student presents the thesis results in three stages.

   (i) **Thesis Content Seminar.** This is an opportunity for the student to present his/her thesis results to department members. The presentation frequently takes place within one of the regular departmental research seminars.

   (ii) **Departmental Oral Examination.** The student gives a 20-minute summary of the thesis and must defend it before a departmental examination committee. Copies of the thesis should be available two weeks before the departmental oral examination. The committee may approve the thesis without reservations, or approve the thesis on condition that revision be made, or require the student to take another departmental oral examination.

   (iii) **Final Oral Examination.** Eight weeks after the successful completion of the departmental oral, the student proceeds to the final oral examination conducted by the School of Graduate Studies. The thesis is sent to an external reader who submits a report two weeks prior to the examination; this report is circulated to members of the examination committee and to the student. The examination committee consists of four to six faculty members; it is recommended that the external reader attend the examination. The student gives a 20-minute summary of the thesis, which is followed by a question period.

As an alternative to the above examination procedure, it will sometimes be possible, on the PhD candidate's initiative and with the agreement of the candidate's academic advisor, to substitute a 50 minute presentation for the 20 minute presentation in the departmental oral examination and the final oral examination. The math department will attempt to accommodate such requests though technical and administrative considerations (space and scheduling issues, communication issues when some committee members are not
physically present, compliance issues with SGS rules, etc.) may prevent this alternative. It
is recommended that such requests will be made at least 4 weeks in advance of the
departmental examination. It is recommended that the 50 minutes option for the final oral
examination not be considered when the external examiner is participating by teleconference.

5. Students are expected to become extensively involved in departmental life (seminars,
colloquia and related activities).

Administration of the Graduate Program

A central administration authority called the School of Graduate Studies establishes the basic
policies and procedures governing all graduate study at the University of Toronto. Detailed
information about the School is obtained in its calendar, distributed to new graduate students
during registration week.

The Department of Mathematics has its own graduate administrative body—the graduate
committee—composed of 6-8 faculty members appointed by the chair of the department, and
five graduate students elected by the Mathematics Graduate Students Association. One of the
faculty members is the graduate coordinator, who is responsible for the day-to-day operation
of the program. The graduate committee meets frequently throughout the year to consider
matters such as admissions, scholarships, course offerings, and departmental policies
pertaining to graduate students. Student members are not permitted to attend meetings at
which the agenda concerns confidential matters relating to other students. Information
regarding appeals of academic decisions is given in the Grading Procedures section of the
Calendar of the School of Graduate Studies. Students may also consult the Graduate
Coordinator (or the student member of the departmental Graduate Appeals Committee)
regarding information about such appeals.

General Outline of the 2013-2014 Academic Year

<table>
<thead>
<tr>
<th>Registration</th>
<th>August 12 – September 13, 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Term</td>
<td>Classes begin Monday, September 9, 2013</td>
</tr>
<tr>
<td>Spring Term</td>
<td>Classes begin Monday, January 6, 2014</td>
</tr>
</tbody>
</table>

Official Holidays (University Closed):

| Labour Day       | Monday, September 2, 2013 |
| Thanksgiving Day | Monday, October 14, 2013 |
| Christmas/New Year | Monday, December 23, 2013 – Friday, January 3, 2014 |
| Family Day       | Monday, February 17, 2014 |
| Good Friday      | Friday, April 18, 2014 |
| Victoria Day     | Monday, May 19, 2014 |
| Canada Day       | Tuesday, July 1, 2014 |
| Civic Holiday    | Monday, August 4, 2014 |
4. GRADUATE COURSES

The following is a list and description of the core courses offered to graduate students in the 2013-2014 academic year. These are the basic beginning graduate courses. They are designed to help the student broaden and strengthen his/her general background in mathematics prior to specializing towards a thesis. A student with a strong background in the area of any of the core courses should not take that particular course. A complete listing of all graduate courses on offer in a given year is available from the mathematics department website. These include cross-listed graduate courses and topics courses. In addition, graduate students may take several intermediate (300-level) undergraduate courses (listed in the Faculty of Arts and Science Calendar) if their background is felt to be weak in some area; no graduate course credit is given for these courses.

There are three other means by which graduate students may obtain course credit, apart from completing the formal courses listed on the following pages. In each of these cases, prior approval of the graduate coordinator is required.

1. Students may take a suitable graduate course offered by another department. Normally at least two-thirds of the course requirements for each degree should be in the Mathematics Department.

2. It is sometimes possible to obtain course credit for appropriately extensive participation in a research seminar (see Research Activities section).

3. It is also possible to obtain a course credit by working on an individual reading course under the supervision of one of the faculty members, provided the material covered is not available in one of the formal courses or research seminars. (Note: this is distinct from the MAT 4000Y Supervised Research Project required of M.Sc. students.)

Most courses meet for three hours each week, either in three one-hour sessions or two longer sessions. For some courses, particularly those cross-listed with undergraduate courses, the times and locations of classes will be set in advance of the start of term. For other courses, the times and locations of classes will be established at organizational meetings during the first week of term, so that a time convenient for all participants may be arranged. During registration week, students should consult the math department website for class and organization meeting times and locations: http://www.math.toronto.edu/cms/tentative-2013-2014-graduate-courses-timetable/
CORE COURSES

MAT 1000HF (MAT 457H1F)
REAL ANALYSIS I
A. Burchard

Measure Theory: Lebesgue measure and integration, convergence theorems, Fubini’s theorem, Lebesgue differentiation theorem, abstract measures, Caratheodory extension theorem, Radon-Nikodym theorem.


Textbook:
Gerald Folland, Real Analysis: Modern Techniques and their Applications, Wiley

References:
Elias Stein and Rami Shakarchi, Measure Theory, Integration, and Hilbert Spaces
Elliott H. Lieb and Michael Loss, Analysis, AMS Graduate Texts in Mathematics, 14 (either edition)
H. L. Royden, Real Analysis, Macmillan, 1998
A. N. Kolmogorov and S. V. Fomin: Introductory Real Analysis, 1975

MAT 1001HS (MAT 458H1S)
REAL ANALYSIS II
A. Burchard

Fourier analysis: Fourier series and transform, convergence results, Fourier inversion theorem, $L$-theory, estimates, convolutions.


Textbook:
Gerald Folland, Real Analysis: Modern Techniques and their Applications, Wiley

References:
Katznelson: Harmonic Analysis, published by Dover or Cambridge Press
Elias Stein and Rami Shakarchi: Functional Analysis: Introduction to Further Topics in Analysis (Princeton Lectures in Analysis) (Book 4)
Lieb and Loss: Analysis 2nd edition, Graduate studies in Mathematics, AMS
MAT 1002HS (MAT 454H1S)  
COMPLEX ANALYSIS  
J. Bland

2. Harmonic functions. Poisson’s integral formula and Dirichlet’s problem
3. Conformal mapping, Riemann mapping theorem.
4. Analytic continuation, Monodromy Theorem, Riemann surfaces.
5. Modular functions and the Picard Theorems.
6. Other topics are possible, like product theorems, elliptic functions, and non-isolated removability theorems.

**Recommended prerequisites:** A first course in complex analysis and a course in real analysis. Measure theory is not required.

**Main References:**
L. Ahlfors: Complex Analysis, 3rd Edition  
Stein and Shakarchi: Complex Analysis

**Additional References:**
T. Gamelin, Complex Analysis  
W. Rudin, Real and Complex Analysis, 2nd or 3rd edition  
D. Sarason, Complex Function Theory

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MAT 1060HF  
PARTIAL DIFFERENTIAL EQUATIONS I  
M. Pugh

This is a basic introduction to partial differential equations as they arise in physics, geometry and optimization. It is meant to be accessible to beginners with little or no prior knowledge of the field. It is also meant to introduce beautiful ideas and techniques, which are part of most analysts’ basic bag of tools. A key theme will be the development of techniques for studying non-smooth solutions to these equations.

**Textbook:**

MAT 1061HS  
PARTIAL DIFFERENTIAL EQUATIONS II  
I.M. Sigal

This course will consider a range of mostly nonlinear partial differential equations, including elliptic and parabolic PDE, as well as hyperbolic and other nonlinear wave equations. In order to study these equations, we will develop a variety of methods, including variational techniques, and fixed point theorems. One important theme will be the relationship between variational questions, such as critical Sobolev exponents, and issues related to nonlinear evolution equations, such as finite-time blowup of solutions and/or long-time asymptotics.
The prerequisites for the course include familiarity with Sobolev and other function spaces, and in particular with fundamental embedding and compactness theorems.

Other topics in PDE will also be discussed.

Reference:
Lawrence Evans: Partial Differential Equations

MAT 1100HF
ALGEBRA I
R.-O. Buchweitz


Group Theory: Isomorphism theorems, group actions, Jordan-Hölder theorem, Sylow theorems, direct and semidirect products, finitely generated abelian groups, simple groups, symmetric groups, linear groups, nilpotent and solvable groups, generators and relations.

Ring Theory: Rings, ideals, Euclidean domains, principal ideal domains, and unique factorization domains.

Modules: Modules and algebras over a ring, tensor products, modules over a principal ideal domain.

Recommended prerequisites are a full year undergraduate course in Linear Algebra and one term of an introductory undergraduate course in higher algebra, covering, at least, basic group theory. While this material will be reviewed in the course, it will be done at "high speed", assuming that you have already some familiarity with the basics. You will be very well prepared indeed, if you have no difficulties reading and understanding the book, listed here under "Other References", M. Artin: Algebra that the author wrote for his undergraduate algebra courses at MIT.

Textbooks:
Dummit and Foote: Abstract Algebra, 2nd Edition

Other References:
Jacobson: Basic Algebra, Volumes I and II.
Cohn: Basic Algebra
M. Artin: Algebra.
MAT 1101HS
ALGEBRA II
R.-O. Buchweitz

Fields: Algebraic and transcendental extensions, normal and separable extensions, fundamental theorem of Galois theory, solution of equations by radicals.

Commutative Rings: Noetherian rings, Hilbert basis theorem, invariant theory, Hilbert Nullstellensatz, primary decomposition, affine algebraic varieties. structure of semisimple algebras, application to representation theory of finite groups.

Textbooks:
Dummit and Foote: Abstract Algebra, 3rd Edition

Other References:
Jacobson: Basic Algebra, Volumes I and II.
Cohn: Basic Algebra
M. Artin: Algebra.

MAT 1300HF
TOPOLOGY I
L. Jeffrey

Local differential geometry: the differential, the inverse function theorem, smooth manifolds, the tangent space, immersions and submersions, regular points, transversality, Sard’s theorem, the Whitney embedding theorem, smooth approximation, tubular neighborhoods, the Brouwer fixed point theorem.

Differential forms: exterior algebra, forms, pullbacks, integration, Stokes’ theorem, div grad curl and all, Lagrange’s equation and Maxwell’s equations, homotopies and Poincare’s lemma, linking numbers.

Prerequisites: linear algebra; vector calculus; point set topology

Textbook:
John M. Lee: Introduction to Smooth Manifolds

MAT 1301HS
TOPOLOGY II
R. Young

Fundamental groups: paths and homotopies, the fundamental group, coverings and the fundamental group of the circle, Van-Kampen’s theorem, the general theory of covering spaces.

Homology: simplices and boundaries, prisms and homotopies, abstract nonsense and diagram chasing, axiomatics, degrees, CW and cellular homology, subdivision and excision, the
generalized Jordan curve theorem, salad bowls and Borsuk-Ulam, cohomology and de-Rham’s theorem, products.

**Textbook:**
Allen Hatcher, Algebraic Topology

**Recommended Textbooks:**
Munkres, Topology
Munkres, Algebraic Topology

### 2013-14 TOPICS COURSES AND CROSS-LISTED UNDERGRADUATE/GRADUATE COURSES


#### INDIVIDUAL READING COURSES

Students requiring individual course numbers:

**MAT 1900Y/1901H/1902H**
**READING IN PURE MATHEMATICS**
Numbers assigned for students wishing individual instruction in an area of pure mathematics.

**MAT 1950Y/1951H/1952H**
**READING IN APPLIED MATHEMATICS**
Numbers assigned for students wishing individual instruction in an area of applied mathematics.

#### COURSE IN TEACHING TECHNIQUES

The following course is offered to help train students to become effective lecturers. It is not for degree credit and is not to be offered every year.

**MAT 1499HS**
**TEACHING LARGE MATHEMATICS CLASSES**
J. Repka

The goals of the course include techniques for teaching large classes, sensitivity to possible problems, and developing an ability to criticize one’s own teaching and correct problems.

Assignments will include such things as preparing sample classes, tests, assignments, course outlines, designs for new courses, instructions for teaching assistants, identifying and dealing with various types of problems, dealing with administrative requirements, etc.

The course will also include teaching a few classes in a large course under the supervision of the instructor. A video camera will be available to enable students to tape their teaching for later (private) assessment.
COURSES FOR GRADUATE STUDENTS FROM OTHER DEPARTMENTS

(Math graduate students cannot take the following courses for graduate credit.)

MAT 2000Y  READINGS IN THEORETICAL MATHEMATICS
MAT 2001H  READINGS IN THEORETICAL MATHEMATICS I
MAT 2002H  READINGS IN THEORETICAL MATHEMATICS II

(These courses are used as reading courses for engineering and science students in need of instruction in special topics in theoretical mathematics. These course numbers can also be used as dual numbers for some third and fourth year undergraduate mathematics courses if the instructor agrees to adapt the courses to the special needs of graduate students. A listing of such courses is available in the 2013-2014 Faculty of Arts and Science Calendar. Students taking these courses should get an enrolment form from the graduate studies office of the Mathematics Department. Permission from the instructor is required.)

PROFESSIONAL DEVELOPMENT PROGRAMS OFFERED BY SGS

English Language and Writing Support (ELWS)
The English Language and Writing Support program, at the School of Graduate Studies, offers individual consultations, single-session workshops, and free non-credit courses for both native and non-native speakers of English. Information and registration:
http://www.sgs.utoronto.ca/informationfor/students/english.htm

Graduate Professional Skills Program (GPS)
The Graduate Professional Skills program (GPS) is a new initiative from the School of Graduate Studies to help doctoral-stream graduate students become fully prepared for their future. It focuses on skills beyond those conventionally learned within a disciplinary program, skills that may be critical to success in the wide range of careers that graduates enter, both within and outside academe. GPS can help you to communicate effectively, plan and manage your time, be entrepreneurial, understand and apply ethical practices, and work effectively in teams and as leaders. The GPS consists of a range of optional “offerings” with a time commitment roughly equivalent to 60 hours of work. Its successful completion will be recognized by a transcript notation. For more information:
http://www.sgs.utoronto.ca/informationfor/students/profdev/gps.htm

MITACS
Mitacs (www.mitacs.ca) is a national research organization offering unique research and training programs to graduate students and postdoctoral fellows (PDFs) in Canada. For more information:
http://www.sgs.utoronto.ca/informationfor/students/profdev/mitacs.htm

U of T Graduate Enterprise Internship (GEI) Program
U of T’s GEI Program is an exciting six-month paid opportunity for recent graduates and graduate students in science, technology, engineering, and mathematics. The program offers participants a head start in their career development, with available salary subsidy for employers. For more information:
http://graduateinternships.utoronto.ca/
5. RESEARCH ACTIVITIES

The Department of Mathematics offers numerous research activities, in which graduate students are encouraged to participate. Research seminars are organized informally at the beginning of each year by one or more faculty members and/or students, and are offered to faculty and graduate students on a weekly basis throughout the year. The level and specific content of these seminars varies from year to year, depending upon current faculty and student interest, and upon the availability and interests of invited guest lecturers. The following research seminars were offered in the past year:

- Algebra and Geometry Seminar
- Analysis and Applied Math Seminar
- Dynamics Seminar
- Fields Analysis Working Group Seminar
- Fields Colloquium/Seminar in Applied Math
- Ganita Seminar
- Geometric Representation Theory Seminar
- Geometry and Topology Seminar
- Graduate Student Seminar
- Homological Methods Seminar
- Inverse Problems and Image Analysis Seminar
- Number Theory/Representation Theory Seminar
- Operator Theory Seminar
- Probability, Geometry and Groups Learning Seminar
- Probability Study Group
- Student Number Theory Seminar
- Symplectic Seminar
- Teichmuller Theory and Dynamics Learning Seminar
- Toronto Probability Seminar
- Toronto Set Theory Seminar
- Trace Formula Working Seminar
- Women in Mathematics
- Working Group in Hamiltonian Systems Seminar

In addition to the weekly seminars, there are numerous special seminars throughout the year, a series of colloquia, and an active program of visiting lecturers:

- Departmental Colloquium
- Blyth Lecture Series

Graduate students are also encouraged to attend lectures and seminars offered by other departments.
6. ADMISSION REQUIREMENTS AND APPLICATION PROCEDURES

Due to the large numbers of applications received in the Department of Mathematics each year, serious consideration will only be given to applicants with strong backgrounds in theoretical mathematics and with first class academic standing.

Application materials and admission requirements are available from the Department of Mathematics website:

http://www.math.utoronto.ca/cms/potential-students-grad/

Please read all instructions carefully and note the deadlines. In addition, the Department of Mathematics requires three letters of reference. The letters must be from three people familiar with your mathematical work, giving their assessment of your potential for graduate study and research in mathematics.

It is essential that all incoming graduate students have a good command of English. Facility in the English language must be demonstrated by all applicants educated outside Canada whose primary language is not English. This requirement is a condition of admission and should be met before application. Here are three ways to satisfy this requirement: (1) Test of English as a Foreign Language (TOEFL): (a) internet-based test (iBT), minimum score of 22/30 for both the Writing and Speaking sections, with an overall minimum TOEFL score of 93/120, or (b) paper-based test, minimum score 580, with TWE (Test of Written English), minimum score 5.0; (2) a score of at least 85 on the Michigan English Language Assessment Batter (MELAB); (3) a score of at least 7.0 on the International English Language Testing Service (IELTS). Applicants are required to satisfy this requirement by December 20, so that scores are available at the time applications are considered.

Suggested prerequisites:

We recognize that our students come from many different places and with a significant range of differing backgrounds. Hence there is no fixed and rigid list of prerequisites, and applicants are considered and often admitted even if their formal previous mathematical education is very different from the informal list of prerequisites below. In general, we’d like to see some sort of overall mathematical maturity and experience, and we appreciate (though we do not require) evidence of in-depth concentration in one mathematical discipline or another.

Yet here’s a non-binding list of courses that are recommended to applicants from within the University of Toronto in order to be seriously considered for the doctoral stream master’s program. Students coming from other institutions will have to make the appropriate substitutions:

2nd year Advanced ODE’s, e.g. MAT 267H

3\textsuperscript{rd} year \textit{Real Analysis, e.g. MAT 357H}


3\textsuperscript{rd} year \textit{Complex Analysis, e.g. MAT 354H}

Approximate syllabus: Complex numbers, the complex plane and Riemann sphere, Möbius transformations, elementary functions and their mapping properties, conformal mapping, holomorphic functions, Cauchy’s theorem and integral formula. Taylor and Laurent series, maximum modulus principle, Schwarz’s lemma, residue theorem and residue calculus.

3\textsuperscript{rd} year \textit{Algebra, e.g. MAT 347Y}

Approximate syllabus: Groups, subgroups, quotient groups, Sylow theorems, Jordan-Hölder theorem, finitely generated abelian groups, solvable groups. Rings, ideals, Chinese remainder theorem; Euclidean domains and principal ideal domains: unique factorization. Noetherian rings, Hilbert basis theorem. Finitely generated modules. Field extensions, algebraic closure, straight-edge and compass constructions. Galois theory, including insolvability of the quintic.

3\textsuperscript{rd} year \textit{Topology, e.g. MAT 327H}


In addition to that we also value some ability in computer programming and some background in physics (though neither is required).

Likewise here’s a non-binding list of courses that are recommended to applicants from within the University of Toronto in order to be seriously considered for the terminal master’s program. Students coming from other institutions will have to make the appropriate substitutions:

\textit{Linear Algebra, e.g. MAT 224}


21
Groups and Symmetries, e.g. MAT 301


Complex Variables, e.g. MAT 334

Approximate syllabus: Theory of functions of one complex variable, analytic and meromorphic functions. Cauchy’s theorem, residue calculus, conformal mappings, introduction to analytic continuation and harmonic functions.

Real Analysis, e.g. MAT 337


7. FEES AND FINANCIAL ASSISTANCE

Fees

Listed below are the fees for the 2012-13 academic session, including incidental fees and the health insurance premium for visa students. The university has not yet published a listing of fees for 2013-14. For detailed information, visit [http://www.fees.utoronto.ca/](http://www.fees.utoronto.ca/)

<table>
<thead>
<tr>
<th>Program Fee – Domestic Degree Students</th>
<th>Domestic Academic Fees</th>
<th>Incidental &amp; Ancillary Fees</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time</td>
<td>$7,160.00</td>
<td>$1,241.52</td>
<td>$8,401.52</td>
</tr>
<tr>
<td>FT-1 sess. Only</td>
<td>$3,580.00</td>
<td>$643.26</td>
<td>$4,223.26</td>
</tr>
<tr>
<td>Part-time</td>
<td>$2,148.00</td>
<td>$391.08</td>
<td>$2,539.08</td>
</tr>
<tr>
<td>PT-1 sess. Only</td>
<td>$1,074.00</td>
<td>$218.04</td>
<td>$1,292.04</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course Fee – Domestic Non-Degree, Special Students</th>
<th>Initial Course load</th>
<th>Domestic Academic Fees</th>
<th>Incidental &amp; Ancillary Fees</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.50</td>
<td>$1,074.00</td>
<td>$391.08</td>
<td>$1,465.08</td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>$2,148.00</td>
<td>$391.08</td>
<td>$2,539.08</td>
<td></td>
</tr>
</tbody>
</table>

*There may be additional ancillary fees levied for enrolment in specific courses or for individual circumstances. Check your account on ROSI.

<table>
<thead>
<tr>
<th>Program Fee – International Degree Students</th>
<th>International Academic Fees</th>
<th>Incidental &amp; Ancillary Fees</th>
<th>Total**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full-time</td>
<td>$16,886.00</td>
<td>$1,241.52</td>
<td>$18,811.52</td>
</tr>
<tr>
<td>FT-1 sess. Only</td>
<td>$8,443.00</td>
<td>$643.26</td>
<td>$9,770.26</td>
</tr>
<tr>
<td>Part-time</td>
<td>$5,065.80</td>
<td>$391.08</td>
<td>$6,456.88</td>
</tr>
<tr>
<td>PT-1 sess. Only</td>
<td>$2,532.90</td>
<td>$218.04</td>
<td>$3,434.94</td>
</tr>
</tbody>
</table>

In addition, there is a mandatory University Health Insurance Plan premium ($684.00) included in the total fee.
Financial Assistance

Below is a list of those types of financial assistance most commonly awarded to mathematics graduate students in 2012-13. This information should also be applicable for students who wish to apply for the 2013-14 academic year; the deadlines for applications will be altered slightly in accordance with the 2013-14 calendar. Some awards are available from external funding agencies; others come from within the University.

Less common scholarships, offered by smaller or foreign funding agencies, are also available; information about these may be found at http://www.sgs.utoronto.ca/informationfor/students/money.htm.

**Vanier Canada Graduate Scholarships (Vanier CGS) Program**

*Value:* $50,000 per annum for a maximum of 3 years

*Eligibility:* a student must be nominated by a Canadian university. Vanier Scholarships must be held by the student at the university that nominated them. The scholarships are not transferable: they may not be taken to another university. Applicants do not have to be registered as doctoral students at the time of application, but must be registered as doctoral students at a Canadian university when they take up the Vanier Scholarship. Canadian citizens, landed immigrants (permanent residents), and international students are all eligible for Vanier Scholarships. Students who have held or are currently holding Tri-Agency scholarship funding for their doctoral program are not eligible to apply.


*Deadline:* early September. Consult department for deadline.

**Natural Sciences and Engineering Research Council (NSERC) Postgraduate Scholarships and Canada Graduate Scholarships**

*Value:* approx. $17,300-$35,000 for a twelve month period

*Eligibility:* Canadian citizens, permanent residents; first class academic standing; full-time attendance

*Application:* apply through the university you are currently attending; application available at [www.nserc.ca](http://www.nserc.ca)

*Deadline:* early October. Consult department for deadline.

**Ontario Graduate Scholarships (OGS)**

*Value:* approx. $5,000 per term for two or three terms

*Eligibility:* no citizenship restrictions; first class academic standing; full-time attendance at an Ontario university

*Application:* apply through the department you wish to attend ([http://www.sgs.utoronto.ca/informationfor/students/money/support/provincial/OGS.htm](http://www.sgs.utoronto.ca/informationfor/students/money/support/provincial/OGS.htm)).

*Deadline:* Consult department for deadline.
Queen Elizabeth II Graduate Scholarship in Science and Technology (QEII-GSST)

**Value:** approx. $15,000 for a twelve month period

**Eligibility:** Canadian citizens, permanent residents; first class academic standing; full-time attendance

**Application:** OGS application (see above).

**Deadline:** Consult department for deadline.

University of Toronto Fellowships

**Value:** minimum $1,000

**Eligibility:** no citizenship restrictions; at least an A- average; full-time attendance at the University of Toronto

**Application:** graduate school applicants will be considered automatically

**Deadline:** December 13

Connaught International Scholarship for Doctoral Students  (entrance scholarship)

**Value:** The effective value awarded to each student will be $35,000.00 total (including tuition).

Scholarships will continue in the same form throughout the normal period in the funded cohort, provided progress.

**Application:** A graduate school application. Graduate units decide nominations in the winter semester.

**Deadline:** To be considered, international doctoral applicants must submit a graduate school application by December 13

Ontario Trillium Scholarship (OTS) for Doctoral Students  (entrance scholarship)

The Ontario Trillium Scholarship (OTS) is designed to attract international PhD students to the University of Toronto.

**Value:** Each OTS will be worth $40,000 per annum (including tuition), and is renewable for four years, provided progress.

**Application:** A graduate school application. Graduate units decide nominations in the winter semester.

**Deadline:** To be considered, international doctoral applicants must submit a graduate school application by December 13

Research Assistantships

**Value:** a limited amount of funds is available for academically worthy students

**Eligibility:** no citizenship restrictions; full-time attendance; high academic standing

**Application:** graduate school applicants will be considered automatically

**Deadline:** December 13

Teaching Assistantships

**Value:** $41.23 per hour; number of hours per week will not exceed a maximum average of 8

**Eligibility:** full-time students who are accepted by the Mathematics Department (subject to satisfactory performance); may be held in conjunction with other awards

**Application:** forms available in May from the Graduate Office, Department of Mathematics

**Deadline:** early June
**Doctoral Thesis Completion Award (DCA)**
The Department of Mathematics receives funding from the university to help support students beyond the funded cohort: Doctoral Thesis Completion Award. The policy of the mathematics department is to spend its DCA funds aiming to bring the total amount of after-fees funding (including both external and other internal sources) for all fifth-year students who are in good academic standing (including a satisfactory supervisory committee report) to be as close to uniform within that group as feasible, and in as much as possible, close to the level of support funded-cohort students are receiving. Shall there be any DCA funds remaining after that, these funds will be distributed on a similar basis among sixth year students.

**Arts and Science Conference Travel Grant**
An important part of the research process is the presentation of one’s work at scholarly conferences. The purpose of this program is to provide additional funds to enable graduate students in the Faculty of Arts and Science to travel to conferences where they will present their work.

*Value:* varies to a maximum of $1,000

*Eligibility:* no citizenship restrictions; award holders must be doctoral students in the funded cohort. Graduate students may hold only one Travel Grant during their time in the department.

*Eligible Expenses:* Conference registration and abstract submission costs, travel and living expenses.

*Application:* Applications available from the Math Graduate Office; deadline October 1.

*Selection Criteria:* Past academic performance, need to attend conference for professional development, quality of abstract. Preference will be given to students near the end of their degrees.

**School of Graduate Studies Conference Grant**
The School of Graduate Studies Conference Grant program is intended to encourage students in doctoral-stream programs to actively present their research at a regional, national or international conference or equivalent academic event early in their program.

*Value:* The value will be based on the event’s registration-fee (at the student-rate) as well as a pre-determined amount based on the location of the event.

*Eligibility:* no citizenship restrictions; award holders must be doctoral-stream students; registered full-time at the time of application and at the time of conference attendance; in good standing; an active participant. Applicants need not have received confirmation of their participation in the conference at the time of application.

*Application:* For more information and deadlines: [http://www.sgs.utoronto.ca/informationfor/students/money/support/internal.htm - SGS Conference Grant](http://www.sgs.utoronto.ca/informationfor/students/money/support/internal.htm)

*Selection Criteria:* Preference will be given to applicants who are in the early stage of their academic program, have not previously attended a conference during their current program and/or who have not previously received an SGS Conference Grant. The SGS Conference Grant is not intended to be the principal source of funding. Applicants are expected to seek funding from other sources, and must list other resources that will or may be used to support their conference attendance.
**Department of Mathematics Policy on Financial Support of Graduate Students**

**Ph.D. Students:** At the time of admission to the Ph.D. program, students will normally be guaranteed support for a period of four years (five years in the case of students admitted directly from a Bachelor’s program), except that students who complete their degree requirements earlier will not be supported past the end of the academic year in which they finish. This guarantee will be made up of a mix of fellowships (including external awards such as NSERC, OGS), teaching assistantships and other sources of funding, at the discretion of the Department; and is subject to satisfactory academic progress, the maintenance of good standing, and in the case of teaching assistantships, satisfactory performance in that role, as judged by the Department. Absent this, support may be reduced, suspended, or discontinued.

In exceptional circumstances some funding may be provided to students in a subsequent year, but the Department expects that students will normally have completed their degree requirements within the four-year period.

**M.Sc. Students:** Students who are granted provisional admission to the Ph.D. program at the time of admission will receive financial support, for one year only. All full-time students in the first or second year of a Master’s program are eligible for teaching assistant work (subject to availability and satisfactory performance).

### 8. OTHER INFORMATION

The Department of Mathematics is located in the heart of the University of Toronto, which in turn is located in the heart of downtown Toronto. Students therefore have access to a wide range of facilities and services. A list appears below.

**Facilities and Services**

**Library Facilities**

The University of Toronto Library system is the 4th largest academic research library in North America. It contains over 4 million print volumes as well as a vast assortment of electronic resources. The Mathematical Sciences Library (MSL) is in the same building as the Mathematics Department. The majority of mathematics journals held by the University of Toronto are housed in the MSL, with some being held in the Gerstein Science Information Centre. The MSL's collection also contains over 20,000 books. The MSL website includes an interface with the UofT catalogue that includes the collections of all the libraries on the St. George, Mississauga, and Scarborough campuses and includes links to online books, journals and abstract and indexing databases including MathSciNet. The MSL offers a wireless environment with study spaces for research. Each graduate student in mathematics receives a photocopying allowance. The Gerstein Science Information Centre also has a comprehensive collection of mathematics books up to 1998.
**St. George T-Card Office**
North lobby, Room 2054A, 2nd floor
Robarts Library, 130 St. George Street
tcard.office@utoronto.ca
416-946-8047
http://www.utoronto.ca/tcard/
- University of Toronto TCard is a photo ID smartcard which provides identification for academic purposes, student activities and services, facility access and a Library Card.

**Mathematics Library**
40 St. George Street, Room 6141
Toronto, Ontario M5S 3G3
416-978-8624
416-978-4107 (Fax)
mathlib@math.toronto.edu
http://www.library.utoronto.ca/math/
- Hours: M-F, 9 – 5; Summer hours: M-F, 9 – 4:30

**Gerstein Science Information Centre**
7 - 9 King’s College Circle
Toronto, Ontario M5S 1A5
Phone: 416-978-2280
Fax: 416-971-2848
ask.gerstein@utoronto.ca
http://www.library.utoronto.ca/gerstein

**Computer Facilities**

All faculty and graduate students can request accounts on the main departmental server and the departmental compute server (these servers are quad-processor Sun X4200 servers with 16GB of RAM running Red Hat Enterprise Linux 5). These accounts give access to electronic mail facilities which are also remotely accessible via secure IMAP or webmail, to the internet including the ability to put a webpage on the departmental webservice (see http://www.math.toronto.edu/intro.html for a very brief introduction to the computing resources in the department), many mathematical software packages (for example, Maple, Matlab, Mathematica, pari/gp, octave), scientific and other graphics programs (most of the symbolic manipulators, gimp), software compilers (supporting, for example, fortran77, fortran95, C, C++, java), a rich mathematical software library, mathematical typesetting programs (TeX, LaTeX), etc. There are wiki and blog servers available to users. There is a public Computer Room (BA6200) in addition to machines in individual offices. University managed wireless connectivity is available for most people in the department.

Applications for math department computer accounts are available from the Mathematics Graduate Office.
**Housing**

The university operates five graduate student residences-apartment complexes on or near the campus, ranging from unfurnished family apartments to the more conventional bed-and-board residences. In addition, the University Housing Service provides a listing of privately owned rooms, apartments and houses available for students to rent. Students should keep in mind that accommodation could be expensive and limited, particularly in downtown Toronto. It is therefore advisable to make inquiries well in advance and to arrive in Toronto a few days prior to the start of term. Students can expect to pay anywhere between $500 to $1,000 per month on accommodation and from $300 to $500 per month on food, travel and household necessities.

**University Housing Service**

214 College Street, 1st Floor
Toronto, Ontario M5T 2Z9
416-978-8045
416-978-1616 (Fax)
[housing.services@utoronto.ca](mailto:housing.services@utoronto.ca)
[http://www.housing.utoronto.ca](http://www.housing.utoronto.ca)

**Health Services**

The University of Toronto Health Service offers medical services and referrals to private physicians for University of Toronto students. Most of these services are free of charge if you are covered under Ontario Health Coverage (OHIP), or the University Health Insurance Plan (UHIP) for visa students. OHIP application forms and information are available from the University Health Services. UHIP coverage for visa students is compulsory and is arranged during registration at the Centre for International Experience.

**University Health Service**

214 College Street, 2nd Floor
Toronto, Ontario M5T 2Z9
416-978-8030
416-978-2089 (Fax)
[http://www.healthservice.utoronto.ca/](http://www.healthservice.utoronto.ca/)
- Medical assistance for University of Toronto students
- Application forms for Ontario Health Coverage

**Centre for International Experience**

Cumberland House, 33 St. George Street
416-978-2564
416-978-4090 (Fax)
[http://cie.utoronto.ca/](http://cie.utoronto.ca/)
- University Health Insurance Plan (UHIP) registration at Cumberland House
**Students with Disabilities**

Services and facilities for students with disabilities are available at the University of Toronto. The University of Toronto’s Accessibility Services facilitates the inclusion of students with hidden or obvious disabilities and health conditions into university life. Services are provided to students with a documented disability, be it physical, sensory, a learning disability or a mental health condition, temporary or long-term.

**Accessibility Services**
Location 1: 1st Floor, Robarts Library, 130 St. George Street, Toronto, ON M5S 3H1
Voice: 416-978-8060
Fax: 416-978-8246
TTY: 416-978-1902
Email: accessibility.services@utoronto.ca

Location 2: 215 Huron Street, 9th Floor, Room 939 Toronto, ON M5S 1A2
Voice: 416 978-7677
Fax: 416 978-5729
TTY: 416 978-1902
Email: as.huronstreet@utoronto.ca
http://www.accessibility.utoronto.ca

**International Students**

The Centre for International Experience (CIE) offers many services to international students, including an orientation program in late August – early September, individual counselling whenever appropriate, and an English language program. In addition, the CIE contacts all foreign students once they have been accepted into the graduate program, to provide information and advice concerning immigration procedures (visa and student authorization forms), employment restrictions and authorization while in Canada, and other relevant matters.

**Centre for International Experience**
Cumberland House, 33 St. George Street, and Koffler Student Centre, Room 201, 214 College Street
416-978-2564
416-978-4090 (Fax)
http://cie.utoronto.ca/
- Serves international students coming to U of T and domestic students looking to go abroad
- University Health Insurance Plan (UHIP) registration at Cumberland House

**Athletics & Recreation**

A wide range of athletic facilities are available within the university, including an arena and stadium, playing fields, swimming pools, squash, tennis, badminton, volleyball and basketball courts, running tracks, archery and golf ranges, fencing salons, exercise and wrestling rooms, dance studios, saunas, lockers and a sports store. Instruction courses, exercise classes and fitness testing are regularly offered, and there is an extensive intramural program with several levels of competition in more than 30 sports.
Other recreational activities and facilities are also available within the university, such as theatre, music, pubs, dances, art exhibitions, a wide range of clubs, debates lectures and seminars, reading rooms, cafeterias and chapels. University of Toronto students also enjoy easy access (walking distance or only a few minutes by subway) to symphony concerts, theatres, ballet, operas, movies, restaurants and shopping.

*The Athletic Centre*
55 Harbord Street
Toronto, Ontario M5S 2W6
416-978-3437
416-978-6978 (Fax)
www.athletics.utoronto.ca

• Multi-use health and fitness facility
• Members of the Athletic Centre also enjoy access to the state-of-the-art facilities at the new Varsity Centre, located at 299 Bloor Street West.
• All U of T students are automatically members of the Athletic Centre and Varsity Centre.

*Hart House*
7 Hart House Circle
Toronto, Ontario M5S 3H3
416-978-2452
inquiries@harthouse.ca
http://www.harthouse.ca

• University of Toronto centre for arts, culture and recreation

*Graduate Student Associations*

Every graduate student at the University of Toronto is automatically a member of the Graduate Student Union (GSU). Graduate students in the Department of Mathematics are also members of the Mathematical Graduate Students Association (MGSA). Between them, these associations sponsor many events every year, including parties, pubs, dances, outings and more serious endeavours such as seminars and lectures.

*Mathematics Graduate Student Union*
Department of Mathematics
40 St. George Street, Room 6290
mgsa@math.utoronto.ca
http://www.math.toronto.edu/mgsa/

*Graduate Students’ Union*
16 Bancroft Avenue
Toronto, Ontario M5S 1C1
416-978-2391, 416-946-8699
info@utgsu.ca
http://www.utgsu.ca

Health and Dental Insurance Office: 416-978-8465 / health@utgsu.ca

• The Graduate Students’ Union at the University of Toronto represents over 17,000 students studying in over 80 departments. It advocates for increased student representation, funding,
and provided services such as health insurance, confidential advice, and a voice for the graduate student body on the various committees of the University.

Other Contacts and Sources of Information

Mathematics Graduate Office
Department of Mathematics
University of Toronto
40 St. George St., Room 6166
Toronto, Ontario M5S 2E4
416-978-7894
416-978-4107 (Fax)
grad-info@math.toronto.edu
http://www.math.utoronto.ca/cms/graduate-program/
• All matters relating to graduate studies in mathematics at the University of Toronto
• Office Hours: M-F, 9-5

School of Graduate Studies
University of Toronto
63 St. George Street
Toronto, Ontario
Canada M5S 2Z9
416-978-5369
416-978-4367 (Fax)
gr
du$$c$$ate.information@utoronto.ca
http://www.sgs.utoronto.ca
• General information concerning graduate studies at the University of Toronto
• Services include confirmation of registration letters, confirmation of degree letters, legal status changes, legal name changes
• Office Hours: M-F, 10-4

Fees Department
Office of the Comptroller
University of Toronto
215 Huron Street, 3rd Floor
Toronto, Ontario M5S 1A1
416-978-2142
416-978-2610 (Fax)
fees@finance.utoronto.ca
www.fees.utoronto.ca
• Enquiries concerning fees
• Payment of fees

Sexual Harassment Office
University of Toronto
3rd Floor, 40 Sussex Avenue
416-978-3908
http://www.utoronto.ca/sho/
• Students are covered by the Sexual Harassment Policy while on university premises or
carrying on a university-related activity. Complaints and requests for information are confidential.

**Human Resources Development Canada (HRDC)**

25 St. Clair Avenue East, 1st Floor or City Hall, 100 Queen Street West, 1st Floor
1-800-206-7218

- To obtain a Social Insurance Number (in person only). Office hours: Monday-Friday, 08:30-16:00
  Supporting documentation must be original, e.g. student authorization and an offer of employment letter
- Takes an average of 4 weeks to process
APPENDIX A: COMPREHENSIVE EXAMINATION SYLLABI

Algebra
1. Linear algebra. Students will be expected to have a good grounding in linear algebra, vector spaces, dual spaces, direct sum, linear transformations and matrices, determinants, eigenvectors, minimal polynomials, Jordan canonical form, Cayley-Hamilton theorem, symmetric, alternating and Hermitian forms, polar decompositon.
2. Group Theory. Isomorphism theorems, group actions, Jordan-Hölder theorem, Sylow theorems, direct and semidirect products, finitely generated abelian groups, simple groups, symmetric groups, linear groups, nilpotent and solvable groups, generators and relations.
4. Modules. Modules and algebras over a ring, tensor products, modules over a principal ideal domain, applications to linear algebra, structure of semisimple algebras, application to representation theory of finite groups.
5. Fields. Algebraic and transcendental extensions, normal and separable extensions, fundamental theorem of Galois theory, solution of equations by radicals.

No reference is provided for the linear algebra material.
References for the other material:
Dummit & Foote: Abstract Algebra, Chapters 1-14 (pp. 17-568).
Alperin & Bell: Groups and Representations, Chapter 2 (pp. 39-62), 5, 6 (pp. 107-178).

Complex Analysis
3. Conformal mapping, Riemann mapping theorem.

Note: The material in Ahlfors can largely be replaced by Chapters 10, 11, 12.1-12.6, and 14 of Rudin. But Ahlfors is the official syllabus for this material. The second edition of Ahlfors can be used if it is noted that Section 5.5 in the third edition is Section 5.4 in the second edition.

Real Analysis
References:
1. Background: Royden, Chapters 1 and 2; Folland (Prologue).
2. Basic Measure Theory: Royden, Chapters 3 and 4, for the classical case on the real line (which contains all the basic ideas and essential difficulties), then Chapter 11, Sections 1-4, for the general abstract case; Folland, Chapters 1 and 2.
3. Differentiation: Royden, Chapter 5, for the classical case, then Chapter 11, Sections 5 and 6 for the general case; Folland, Chapter 3 (For differentiation on $[a,b]$ one can restrict the attention to the one dimensional case, which contains all the basic ideas and essential difficulties.)
4. Basic Functional Analysis: Royden, Chapter 10, Sections 1,2,3,4,8; Folland, Chapter 5, Sections 1,2,3,5.

5. $L^p$-Spaces: Royden, Chapter 6 for the classical case, and Chapter 11, Section 7 for the general case; Folland, Chapter 6, Sections 1 and 2, Chapter 7, Section 1.

6. Harmonic Analysis: Katznelson, Chapter 1, Chapter 2, Sections 1 and 2, and Chapter 6, Sections 1 to 4; Folland, Chapter 8, Sections 1,2,3,4,5, and 8. One can restrict the attention to the one dimensional case, as done in Katznelson.

**Topology**

1. local differential geometry: the differential, the inverse function theorem, smooth manifolds, the tangent space, immersions and submersions, regular points, transversality, Sard’s theorem, the Whitney embedding theorem, smooth approximation, tubular neighborhoods, the Brouwer fixed point theorem.

2. differential forms: exterior algebra, forms, pullbacks, d, integration, Stokes’ theorem, div grad curl and all, Lagrange’s equation and Maxwell’s equations, homotopies and Poincare’s lemma, linking numbers.

3. fundamental groups: paths and homotopies, the fundamental group, coverings and the fundamental group of the circle, Van-Kampen’s theorem, the general theory of covering spaces.

4. homology: simplices and boundaries, prisms and homotopies, abstract nonsense and diagram chasing, axiomatics, degrees, CW and cellular homology, subdivision and excision, the generalized Jordan curve theorem, salad bowls and Borsuk-Ulam, cohomology and de-Rham’s theorem, products.

**Partial Differential Equations**

Note: This is meant to be an exam syllabus not a course outline.

As such, topics are not necessarily ordered as in a logical development.

1) **Basic Notions in Ordinary Differential Equations:** Fundamental theorem on existence and uniqueness of solutions of $y' = f(x,y)$ when $f$ is Lipschitz w.r.t. $y$. Fixed point theorem, Picard iterates. (Various topics in PDE will also assume familiarity with undergraduate ODE material.)

2) Basic Notions in Linear Partial Differential Equations


   b) **Parabolic PDEs:** Heat Equation, fundamental solution of the heat equation, mean value property, maximum principle, regularity properties, initial value problem for the heat equation, semigroups, gradient flows

   c) **Hyperbolic PDEs:** Wave equation, fundamental solution of the wave equation, spherical means, Huygen’s principle, conservation of energy, finite speed of propagation, initial value problem for the wave equation, other hyperbolic PDEs.

3) Distributions; Fourier Transform

4) **Sobolev spaces; Weak Solutions:** Weak derivatives, Sobolev spaces $W^{k,p}$, $L^2$ based fractional Sobolev spaces $H^s$, Approximation properties, Extensions, Traces, Sobolev inequalities, Poincaré lemma *Weak solutions and regularity theory is enmeshed with the topics on the exam.*

5) **Nonlinear PDEs:** First-Order: Method of characteristics, Hamilton-Jacobi equations, Conservation laws, weak solutions, shocks and rarefactions, uniqueness and entropy solutions, Second-Order: gradient flows, linearization around special solutions, vanishing viscosity limit of Burger’s equation.

6) **Calculus of variations:** direct methods, convexity, weak-* continuity and compactness, first and
second variations, Euler-Lagrange equation, Lagrange multipliers, constraints

References:
V. I. Arnold: Ordinary differential equations 1992
G.B. Folland: Introduction to partial differential equations 1995
W. Hurewicz: Lectures on ordinary differential equations 1990
A student planning to specialize in applied mathematics must pass three comprehensive exams, at least two of which are a general written exam (algebra, analysis (real and complex), topology, or partial differential equations (PDE I and PDE II)). The following are samples of other exam topics.

**Combinatorics**


2) **Graph Theory**: Trees, connectivity, bipartite graphs, minimal spanning trees, Eulerian and Hamiltonian graphs, travelling salesman and chinese postman problems, matchings, chromatic number, perfect graphs.

3) **Design Theory**: Definitions, examples, finite fields, finite affine and projective spaces, Fisher’s inequality, symmetric designs, statement of Wilson’s Theorem and Wilson’s Fundamental Construction.

4) **Coding Theory**: Linear codes, sphere packing, Hamming and Plotkin bounds, perfect codes, polynomial over finite fields.

5) **Algorithms and Complexity**: Algorithms for listing permutations, combinations, subsets. Analysis of algorithms, basic concepts such as NP, and #P, and NPC.

References:

**Control Theory and Optimization**

1) **Control Theory**: Qualitative properties of the reachable sets, Lie bracket and Lie determined systems, linear theory, stability and feedback. *(Reference: V. Jurdjevic: Geometric Control Theory, Cambridge University Press, Chapters 1,2 and 3)*

2) **Optimal Control**: Linear-quadratic problems, symplectic form, Lagrangians, the Riccati equation, the Maximum Principle and its relation to the calculus of variations. *(Reference: V. Jurdjevic: Geometric Control Theory, Cambridge University Press, Chapters 7, 8, 11)*

3) **Linear Programming**: Convex analysis, simplex algorithm, duality, computational complexity and Karmarkar’s Algorithm. *(Reference: Bazaraa, Jarvis & Sherali: Linear Programming and Network Flows, Wiley, 1990, Chapters 2,3,4,6,8)*

4) **Nonlinear Programming**: Unconstrained and constrained nonlinear problems. Introduction to computational methods. *(Reference: Luenberger: Linear and Nonlinear Programming, Addison-Wesley, 1984, Chapters 6,7,10)*

**Fluid Mechanics**

It is expected that a student has a basic knowledge of real and complex analysis including ordinary differential equations. The extra mathematics required includes:

1) **Partial differential equations**: Laplace’s equation, properties of harmonic functions, potential theory, heat equation, wave equation. Solutions through series and transform techniques. Bessel functions and Legendre functions. Distributions. (e.g. Duff and Naylor)

2) **Asymptotic and perturbation techniques**: Asymptotic series solutions of ordinary differential equations, asymptotic expansion of integrals. Singular perturbation problems, boundary layer methods, WKB theory, multiple time-scale analysis. (e.g. Bender and Orszag)

Basic physical properties of fluids. Derivation of the Navier-Stokes equations for a viscous compressible fluid; vorticity; energy balance. Simple exact solutions of the Navier-Stokes equations. Slow viscous motions; Stokes flows; Oseen flow. Irrotational flow; sources and sinks; complex variable methods. Boundary layer approximation. Blasius flow; separation; jets and wakes. Rotating flows; geostrophic
behaviour. Free surface flows; wave propagation. Simple unsteady boundary layer flows; Stokes layers. Shock waves in a tube; supersonic flow.

**General Relativity and Classical Mechanics**

1) Space-times as Lorentz manifolds. Differential geometry (curvature, etc.) and local and global properties of Lorentz manifolds.
2) Field equations of general relativity, stationary and static space-times. Exact solutions. Schwarzschild, Kruskal, Kerr solutions. Cosmological models: Robertson-Walker and Friedman models and their properties.
3) Cauchy problem for the field equations. Classification of space-times.
4) Symplectic geometry, symplectic structure of cotangent bundles, Poisson brackets.
5) Hamiltonian equations, canonical transformations, Legendre transformations, Lagrangian systems, Hamilton-Jacobi theory.

**References:**
Hawking & Ellis: Large Scale Structure of Space-Time, Chapters 2,3,4,5.
O’Neill: Semi-Riemannian Geometry with Applications to Relativity.
Wald: *General Relativity*, Chapters 1-6 and Appendices A-C and E

**Mathematical Finance**

1) **Stochastic calculus:** Martingales, Ito’s lemma, Girsanov’s theorem, stochastic differential equations, stopping times. *(Reference: Baxter & Rennie, Financial Calculus)*

**Probability**
The Probability Exam is a written exam and is administered by the Department of Statistics. It is based on material covered in STA 2111F and STA 2211S. It is normally scheduled in May.
Topics covered include:

1) **Elementary probability theory:** Bernoulli trials, combinatorics, properties of standard probability distributions, Poisson processes, Markov chains
2) **Probability spaces:** measure theory and Lebesgue integration, extension theorems, Borel-Cantellis lemmas, product measures and independence, Fubini’s Theorem
3) **Random variables and expectations:** probability distributions, Radon-Nikodym derivatives and densities, convergence theorems such as dominated convergence, monotone convergence, etc
4) **Limit theorems:** inequalities, weak and strong laws of large numbers for sums of i.i.d. random variables, Glivenko-Cantelli Theorem, weak convergence (convergence in distribution), continuity theorem for characteristic functions, Central Limit theorems
5) **Conditional probability and expectation:** definitions and properties, statistical applications, martingales
6) Basics of Brownian motion and diffusions

**References**
Most of the above material is covered in any one of the following texts:
P. Billingsley: Probability and Measure 1995
L. Breiman: *Probability* 1992
R.M. Dudley: Real Analysis and Probability 1989
Quantum Field Theory


3) **Relativistic quantum field theory**: The Klein-Gordon and Dirac equations. Fock space for spin 0 and spin $\frac{1}{2}$ particles. Creation and annihilation operators. Quantum fields as operator-valued distributions. The Gupta-Bleuler formalism for photons and gauge freedom.

References:

*Intermediate:*

*Advanced:*
M. Reed & B. Simon: Methods of Modern Mathematical Physics, vols. 1-4, 1972-78.
APPENDIX C: PH.D. DEGREES CONFERRED FROM 2000-2013

2000
CALIN, Ovidiu (Differential Geometry) The Missing Direction and Differential Geometry on Heisenberg Manifolds
DERANGO, Alessandro (C*-Algebras) On C*-Algebras Associated with Homeomorphisms of the Unit Circle
HIRSCHORN, James (Set Theory) Cohen and Random Reals
MADORE, Blair (Ergodic Theory) Rank One Group Actions with Simple Mixing Z Subactions
MARTINEZ-AVENDAÑO, Rubén (Operator Theory) Hankel Operators and Generalizations
MERKLI, Marco (Mathematical Physics) Positive Commutator Method in Non-Equilibrium Statistical Mechanics
MIGHTON, John (Knot Theory) Topics in Ramsey Theory of Sets of Real Numbers
MOORE, Justin (Set Theory) Topics in Ramsey Theory of Sets of Real Numbers
RAZAK, Shaloub (C*-Algebras) Classification of Simple Stably Projectionless C*-Algebras
SCOTT, Jonathan (Algebraic Topology) Algebraic Structure in Loop Space Homology
ZHAN, Yi (PDE) Viscosity Solution Theory of Nonlinear Degenerate

2001
COLEMAN, James (Nonlinear PDE’s) Blowup Phenomena for the Vector Nonlinear Schrödinger Equation
IZADI, Farz-Ali (Differential Geometry) Rectification of Circles, Spheres, and Classical Geometries
KERR, David (C*-Algebras) Pressure for Automorphisms of Exact C*-Algebras and a Non-Commutative Variational Principle
OLIWA, Chris (Mathematical Physics) Some Mathematical Problems in Inhomogeneous Cosmology
PIVATO, Marcus (Mathematical Finance) Analytical Methods for Multivariate Stable Probability Distributions
POON, Edward (Operator Theory) Frames of Orthogonal Projections
SAUNDERS, David (Mathematical Finance) Mathematical Problems in the Theory of Incomplete Markets
SOLTYS-KULINICZ, Michael (Complexity) The Complexity of Derivations of Matrix Identities
VASILJEVIC, Branislav (Mathematical Physics) Mathematical Theory of Tunneling at Positive Temperatures
YUEN, Waikong (Probability) Application of Geometric Bounds to Convergence Rates of Markov Chains and Markov Processes on R^n

2002
HERNANDEZ-PEREZ, Nicholas (Math. Finance) Applications of Descriptive Measures in Risk Management
KAVEH, Kiumars (Algebraic Geometry) Morse Theory and Euler Characteristic of Sections of Spherical Varieties
MOHAMMADALIKANI, Ramin (Symplectic Geometry) Cohomology Ring of Symplectic Reductions
SOPROUNOV, Ivan (Algebraic Geometry) Parshin’s Symbols and Residues, and Newton Polyhedra
SOPROUNOVA, Eugenia (Algebraic Geometry) Zeros of Systems of Exponential Sums and Trigonometric Polynomials
TOMS, Andrew (Operator Algebras) On Strongly Perfomed K_0 Groups of Simple C*-Algebras
VUKSANOVIC, Vojkan (Set Theory) Canonical Equivalence Relations
ZIMMERMAN, Jason (Control Theory) The Rolling Stone Problem
2003
ADAMUS, Janus (Analytic Geometry) Vertical components in fibre powers of analytic mappings
BUBENIK, Peter (Algebraic Topology) Cell attachments and the homology of loop spaces and differential graded algebras
HO, Nan-Kuo (Symplectic Geometry) The moduli space of gauge equivalence classes of flat connections over a compact nonorientable surface
JONG, Peter (Ergodic Theory) On the Isomorphism Problem of p-Endomorphisms
PEREIRA, Rajesh (Operator Theory) Trace Vectors in Matrix Analysis
STAUBACH, Wolfgang (PDE) Path Integrals, Microlocal Analysis and the Fundamental Solution for Hörmander Laplacians
THERIAULT, Nicolas (Algebraic Number Theory) The discrete logarithm problem in the Jacobian of algebraic curves
TING, Fridolin (Mathematical Physics) Pinning of magnetic vortices by external potential
TSANG, Kin Wai (Operator Algebras) A Classification of Certain Simple Stably Projectionless C*-Algebras

2004
AHMAD, Najma (Applied Math) The geometry of shape recognition via the Monge-Kantorovich optimal transportation problem (in conjunction with Brown University)
BRANKER, Maritza (Several Complex Variables) Weighted approximation in $\mathbb{R}^n$
CHEN, Oliver (Mathematical Finance) Credit barrier models
ESCOBAR ANEL, Marcos (Mathematical Finance) Mathematical treatment of commodity markets
HUNG, Ching-Nam (Operator Algebras) The numerical range and the core of Hilbert-space operators
IVANESCU, Cristian (Operator Algebras) On the classification of simple C*-algebras which are inductive limits of continuous-trace C*-algebras with spectrum the closed interval $[0,1]$
KIRITCHENKO, Valentina (Analytic Geometry) A Gauss-Bonnet Theorem, Chern Classes and an Adjunction Formula for Reductive Groups
KUZNETSOV, Alexey (Mathematical Finance) Solvable Markov processes
LAWI, Stephan (Mathematical Finance) Exactly solvable stochastic integrals and q-deformed processes
SAVU, Anamaria (Probability) Hydrodynamic scaling limit of the continuum solid on solid model
SHEHABI, Zohreh (Differential Geometry) Differential Geometry of Relative Gerbes
SONG, Joon-Hyeok (Symplectic Geometry) Intersection Numbers in q-Hamiltonian Spaces
TIMORIN, Vladlen (Analytic Geometry) Rectifiable Pencils of Conics

2005
DE LOS SANTOS, Alejandro (Mathematical Finance) Liquidity risk estimation: non-gaussian AR models and quantile expansions
HAMILTON, Mark (Symplectic Geometry) Singular Bohr-Sommerfeld Leaves and Geometric Quantization
NIU, Zhuang (Operator Algebras) A classification of the tracially approximately sub-homogeneous C*-algebras
PATANKAR, Vijay (Number Theory) Splitting of Abelian Varieties
POLLANEN, Marco (Probability) Low discrepancy sequences in probability spaces
2006
CHAN, Jackson (Harmonic Analysis) Methods of variations of potential of quasi-periodic Schrödinger equation
DEJAK, Steven (Nonlinear PDE) Long-time dynamics of KdV solitary waves over a variable bottom
DOUGLAS, Andrew (Representation Theory) A classification of the finite dimensional indecomposable representations of the Euclidean algebra \( \mathbb{e}(2) \) having two generators
FU, Guangyu (Probability) Random walks and random polynomials
HERNANDEZ CORTES, Janko (Mathematical Finance) Ergodic properties of some hidden Markov models with applications to mathematical finance
HO, Toan Minh (Operator Algebras) On the inductive limits of homogeneous algebras with diagonal morphisms between building blocks
KNAFO, Emmanuel (Number Theory) Variance of distribution of almost primes in arithmetic progressions
ROBERT GONZALEZ, Leonel (Operator Algebras) Classification of nonsimple approximate interval C*-algebras: the triangular case

2007
CALLAGHAN, Joe (Several Complex Variables) A Green’s function for \( \theta \)-incomplete polynomials
COWARD, Kristofer (Operator Algebras) The Cuntz semigroup as a classification functor for C*-algebras
LANGRIDGE, Allan (Number Theory) Values of Artin L-functions at \( s=1 \)
NAOT, Gad (Knot Theory) The Universal \( sl_2 \) link homology theory
ZHOU, Gang (Mathematical Physics) Asymptotic dynamics of trapped solitons of nonlinear Schrödinger equations with external potentials

2008
BAIRD, Thomas (Symplectic Geometry and Algebraic Topology) Moduli spaces of flat G-bundles over nonorientable surfaces
BROOKE, David (Representation Theory) Resolving Multiplicities in the Tensor Product of Irreducible Representations of Semisimple Lie Algebras
CIUPERCA, Alin (Operator Algebras) Some Properties of the Cuntz Semigroup and an Isomorphism Theorem for a Certain Class of Non-simple C*-algebras
DONIN, Dmitry (Representation Theory and Differential Geometry) Lie Algebras of Differential Operators and D-Modules
FUCHS, Shay (Geometric Quantization) Spin^c quantization, prequantization and cutting
GERACI, Joseph (Quantum Information and Statistical Physics) On the Relation between Quantum Computation and Classical Statistical Mechanics
KLEIN, David (Symplectic geometry) Goldman Flows on Moduli Spaces of Flat Connections on Surfaces
KLEPER, Dvir (Operator Theory) Invariant Subspaces of Composition Operators on Weighted Hardy-Hilbert Spaces
LYNCH, Geoffrey (Algebraic Geometry) The Local Monodromy Operator as an Algebraic Cycle
QUINTANILLA, Maria Teresa (Mathematical Finance) Asymptotic Optimization of Risk Measures
SANTIAGO MORENO, Luis (Operator Algebras) Classification of Non-simple C*-algebras: Inductive Limits of Splitting Interval Algebras
SYLVESTRE, Jeremy (Representation Theory) Twisted Characters of Depth-zero Supercuspidal Representations of GL(n)
TIPU, Vicentiu (Number Theory) Polynomial Divisor Problems
2009
FITZPATRICK, Daniel Sean (Symplectic Geometry) Almost CR quantization via the Index of Transversally Elliptic Dirac Operators
HAMMERLINDL, Andrew (Dynamical Systems) Leaf Conjugacies on the Torus
HOVINEN, Bradford (Commutative Algebra) Matrix Factorizations of the Classical Discriminant
KISSLUNOKO, Veniamine (Algebraic Geometry) The Converse of Abel’s Theorem
KREPSKI, Derek (Symplectic Geometry) Pre-quantization of the Moduli Space of Flat G-bundles
LEE, Brian C. (Symplectic Geometry) Geometric Structures on Spaces of Weighted Submanifolds
LEE, Paul Woon Yin (Symplectic Geometry and Dynamical Systems) Symplectic and Subriemannian Geometry of Optimal Transport
LI, Chao (Automorphic Forms and Representation Theory) A Local Twisted Trace Formula and Twisted Orthogonality Relations
MALONEY, Gregory (Operator Algebras) Dimension Groups and C*-algebras Associated to Multidimensional Continued Fractions
MESARIC, Jeffrey (Partial Differential Equations) Existence of Critical Points for the Ginzburg-Landau Functional on Riemannian Manifolds
MORTARI DE LACERDA, Fernando (Operator Algebras) Tracial State Space of Higher Stable Rank Simple C*-algebras
SIGLOCH, Georg (Mathematical Finance) Utility Indifference Pricing of Credit Instruments
WESSLEN, Maria (Representation Theory) A Diagrammatic Description of Tensor Product Decompositions for SU(3)
ZHURAVLEV, Vladimir (Ergodic Theory) Two Theorems of Dye in the Almost Continuous Category
ZOU, Xiangqun (Partial Differential Equations) On Blow-up of One-dimensional Heat Equations with Polynomial Nonlinearities

2010
ARCHIBALD, Jana (Knot Theory) The Multivariable Alexander Polynomial on Tangles
ARIAN, Hamidreza (Mathematical Finance) Financial Engineering of the Stochastic Correlation in Credit Risk Models,
CLARK, Trevor (Dynamical Systems) Real and Complex Dynamics of Unicritical Maps
FIRSOVA, Tanya (Dynamical Systems) Dynamical Foliations
KONG, Wenbin (Nonlinear PDEs) Singularity Formation in Nonlinear Heat and Mean Curvature Flow Equations
LEUNG, Louis (Knot Theory) Classical Lie Algebra Weight Systems of Arrow Diagrams
MAZIN, Mikhail (Algebraic Geometry) Geometric Theory of Parshin Residues
MCLELLAN, Brendan (Differential Geometry) Non-Abelian Localization and U(1) Chern-Simons Theory
MONDAL, Pinaki (Algebraic Geometry) Towards a Bezout-type Theory of Affine Varieties
MORFIN RAMIREZ, Mario (Dynamical Systems) Grassmann Dynamics
SHORSER, Lindsey (Representation Theory) Scalar and Vector Coherent State Representations of Compact and Non-Compact Symplectic Groups in a Unitary Basis
SOKIC, Miodrag (Set Theory) Ramsey Property of Posets and Related Structures
TZANETEAS, Tim (Mathematical Physics) Abrikosov Lattice Solutions of the Ginzburg-Landau Equations of Superconductivity
ZHANG, Yichao (Analytic Number Theory) L-functions in Number Theory
ZOGHI, Masrour (Symplectic Geometry) The Gromov Width of Coadjoint Orbits of Compact Lie Groups
ZWIERS, Ian (Nonlinear PDEs) Standing Ring Blowup Solutions for the Cubic Nonlinear Schroedinger Equation
2011
ANAPOLITANOS, Ioannis (Math Physics) On van der Waals forces
BLOEMENDAL, Alexander (Probability) Finite Rank Perturbations of Random Matrices and Their Continuum Limits
CARRASCO, Pablo (Dynamical Systems) Compact Dynamical Foliations
DANCO, Zsuzsanna (Knot Theory) A Universal Finite Type Invariant Of Knotted Trivalent Graphs
HOEHN, Logan (Set-theoretic topology) Non-Chainable Continua and Lelek's Problem
JASINSKI, Jakub (Combinatorics) Hrushovski and Ramsey Properties of Classes of Finite Inner Product Structures, Finite Euclidean Metric Spaces and Boron Trees
LAI, Chung Lun Alan (Noncommutative Geometry) On the JLO Character and Loop Quantum Gravity
MARTINEZ RANERO, Carlos (Set Theory) Contributions towards a Fine Structure Theory of Aronszajn Orderings
PASS, Brendan (Geometric Analysis) Structural Results on Optimal Transportation Plans
PIGOTT, Brian (Partial differential equation) Low Regularity Stability for Subcritical Generalized Korteweg-de Vries Equations
ROWE, Barry (Operator Theory) The Left Regular Representation of a Semigroup
SQUIRES, Travis (Algebra) Lie 2-Algebras as Homotopy Algebras Over a Quadratic Operad
TIKUISIS, Aaron (Operator Algebra) The Cuntz Semigroup of C(X,A)
UREN, James (Differential geometry) Toric Varieties Associated with Moduli Spaces
VODA, Mircea (Several Complex Variables) Loewner Theory in Several Complex Variables and Related Problems

2012
BAILEY, Michael (Differential Geometry) On the local and global classification of generalized complex structures
BURDA, Yuri (Algebraic Geometry) Topological Methods in Galois Theory
CHO, Peter Jaehyun (Number Theory) L-functions and Number Theory
CHU, Karene (Geometric Topology) Flat Virtual Pure Tangles
DUDKO, Artem (Dynamical Systems) Dynamics of holomorphic maps: Resurgence of Fatou coordinates, and Poly-time computability of Julia sets
FONTAINE, Bruce (Representation Theory) Bases for Invariant Spaces and Geometric Representation Theory
FRANCETIC, Nevena (Discrete Math) Covering Arrays with Row Limit
ISGUR, Abraham (Combinatorics) Solving Nested Recursions With Trees
KAMALINEJAD, Ehsan (Analysis of PDE) Optimal Transport Approach to Non-linear Evolution Equations
KINZEBULATOV, Damir (Several Complex Variables) Geometric analysis on solutions of some differential inequalities and within restricted classes of holomorphic functions
LEE, Stephen Peter (Algebra) The Pure Virtual Braid Group is Quadratic
LI-BLAND, David (Lie Theory) $\mathcal{L}$-Courant Algebroids and their Applications
MAZZEO, Elio (Ergodic Theory) On $C^1$-rigidity for maps with a break point
PARSONS, Todd (Mathematical Biology) Asymptotic Analysis of Some Stochastic Models from Population Dynamics and Population Genetics
PETZKA, Henning (C*-Algebras) Stably non-stable C*-algebras with no bounded trace
RICHARDS, Geordie (Probability and PDE) Maximal-in-time behavior of deterministic and stochastic dispersive partial differential equations
SANKARAN, Siddarth (Arithemetic Geometry) Special cycles on Shimura curves and the Shimura lift
SHAHROKHI TEHRANI, Shervin (Arithmetic Geometry) Non-holomorphic cuspidal automorphic forms of $GSp(4)$ and the Hodge structure of Siegel threefolds
TAM, Kam-Fai (Number Theory) Transfer relations in essentially tame local Langlands correspondence
VERA PACHECO, Franklin (Algebraic Geometry) Resolution of singularities of pairs preserving semi-simple normal crossings
WATTS, Jordan (Differential Topology) Diffeologies, Differential Spaces, and Symplectic Geometry
YANG, Jihyeon Jessie (Algebraic Geometry) Tropical Severi Varieties and Applications

2013
AMIR-KHOSRAVI, Zavosh (Arithmetic Geometry) Moduli of Abelian Schemes and Serre’s Tensor Construction
ANGHEL, Catalina (Number Theory) The self-power map and its image modulo a prime
CHEN, Shibing (Analysis of PDE) Convex solutions to the power-of-mean curvature flow, conformally invariant inequalities and regularity results in some applications of optimal transportation
DOTTERRER, Dominic (Metric Geometry) The (co)isoperimetric problem in (random) polyhedra
LAPTYEVA, Nataliya (Number Theory) A Variant of Lehmer’s Conjecture in the CM Case
LIU, Xiao (Nonlinear PDEs) Analytical and numerical results for some classes of nonlinear Schrödinger equations
MOURTADA, Mariam (Number Theory) The distribution of values of logarithmic derivatives of real $L$-functions
PYM, Brent (Algebraic Geometry) Poisson structures and Lie algebroids in complex geometry
The Fields Institute for Research in Mathematical Sciences was created in November 1991 with major funding from the Province of Ontario, the Natural Sciences and Engineering Research Council of Canada, and McMaster University, the University of Toronto, and the University of Waterloo. In September 1996 it moved from its temporary location in Waterloo to its permanent site, a new building located at 222 College Street in Toronto, next to the University of Toronto Bookstore. In addition to the three principal sponsoring universities about twenty universities across Canada are affiliated with it.

The mandate of the Fields Institute specifically includes the training of graduate students and this function is given a higher profile than at other similar mathematics research institutes. All major programs run at the institution contain graduate courses which students at any university affiliated with the institute may take for credit and the organizers of major programs are expected to set aside some money to make it possible for graduate students to participate in their program.
Graduate students in the Department of Mathematics are able to access the student web service to change personal information (addresses and telephone numbers), view their academic record and current courses and to enrol in, request or drop courses.

General Information

Student Responsibility

While academic advisors, faculty and staff are available to assist and advise, it is ultimately the student's responsibility to keep personal and academic information up to date at all times and to follow all University, SGS, departmental and program regulations, requirements and deadlines. The student web service makes it easier for students to check and correct this information. If questions arise about requirements, policies and procedures, students are responsible for seeking answers to these questions from staff and advisors.

Important Notes regarding Email and UTORid

The Department of Mathematics and other university offices may send important information to you by email. Please make sure that your email address, your mailing/permanent address and telephone number are up to date at all times. Under University policy, students are required to maintain a University based email account (i.e., ending in utoronto.ca or utoronto.edu), record it in ROSI, and regularly check for messages. That account may be forwarded to another personal account but it is the University account to which the University will send official correspondence.

New students are advised to validate their UTORid at the University Library early. Your UTORid provides you access not only to your University email account but also to Blackboard, the University’s student portal and learning management system. Many courses use the portal to provide online materials, discussion groups, quizzes etc. It is also used by the University and various student groups to make important announcements and administer elections.

Declaration

Use of the SWS to enrol in courses means that you agree to abide by all of the academic and non-academic rules and regulations of the University, the School of Graduate Studies and graduate unit in which you are registered, and assume the obligation to pay academic and incidental fees according to the policies and requirements of the University of Toronto. You normally use the SWS to add or cancel courses. If, for extraordinary reasons, you are unable to use the SWS contact your graduate unit as soon as possible.

Users of the Student Web Service are expected to be responsible when using the SWS and should not attempt to flood the system with requests, or to automate the process of course enrolment. Such activity may clog the system so that other students may be denied access or experience degraded performance. Any student(s) attempting such activity may be denied access to the SWS until after the relevant registration period.
**Personal Identification Number**

Students must log into the SWS using their student number and a personal identification number (PIN). The first time you log in, your PIN will be based on your date of birth (format YYMMDD). For example, if your birth date is April 17, 1982, your initial PIN will be 820417.

When you log in for the first time, the SWS will prompt you to change your PIN. Subsequent access to the system will require this new PIN which should be known only to you. Your student number and PIN together constitute an "electronic signature". *Never give your PIN or student number to someone else.*

Forgotten PIN numbers can be reset by the graduate office. To avoid having to contact the office in person or having to wait for office hours, students can enter answers to a set of questions on the SWS. When you first access the ROSI, the SWS will prompt you to choose three questions from a list. If you later forget your PIN, you can reactivate/reset it online by answering the questions correctly.

**Services Available on the SWS**

- Change PIN number
- View/Change address, telephone number, email
- View final grades
- View academic history or current timetable
- Add/request/drop/list courses or waitlist requests
- View student account information and invoices and update direct deposit details
- Defer payment of tuition (available to recipients of a funding commitment from the graduate unit and to students approved Ontario, Canada and some US government student loan– see note below)
- Print “Educational Credit” tax forms (T2202A)
- Order transcripts
- Order graduation tickets
- View transaction log

**Updating & Checking Personal Information**

Students may view or update their address, telephone number or email address through the Student Web Service. When entering new information, the "add" option should be used. "Change" should only be used to correct information in an otherwise correct record (e.g. typos).

Students can also check other personal information (immigration status, title etc). As immigration status affects fees, all students are advised to check this information at the beginning of each year.

**Request to Register Without Payment (Deferrals) for graduate funding commitments**

Students who are receiving funding as part of the Department of Mathematics' graduate funding commitment may request to register without payment online. Students who are receiving funding outside of the funding commitment must make their request with the Department of Mathematics using the request form found on the SGS website ([http://www.sgs.utoronto.ca/informationfor/students/inform/stuforms.htm](http://www.sgs.utoronto.ca/informationfor/students/inform/stuforms.htm))
For OSAP, CSL and US student Loan recipients

Students who have received notification of an award through the Ontario Student Assistance Program for their U of T program may make their fees arrangements through the SWS up to the registration deadline instead of having to appear at SGS, if the amount of the loan covers the minimum payment and no outstanding fees are owing. The online arrangements may also be available for recipients of Canada Student Loans and some US government loans. Please see the Office of Student Accounts website (www.fees.utoronto.ca) for details.

Requesting Courses

Students may begin requesting courses on August 30. All course requests (requests for courses outside the department) must be approved by the graduate co-ordinator. Students must request their courses by no later than September 22. Courses will be approved or refused before the last date to add courses. Students should check the web for their request status before October 1.

The web service requires full information about a course when a request is being made. Please consult the attached lists from your department. Be sure to enter:

- Course number: e.g. HIS2651Y
- Section Code: usually F, S or Y. This indicates whether the course is offered in the fall session (F), the winter session, i.e., second term (S) or over both (Y).
- Teaching Method: all graduate courses have a teaching method of LEC (lecture).
- Teaching Section: the number of the class. Most graduate courses only have one teaching session (0101). Although there may be only one teaching section the information must still be entered on the system.

NB. Some courses may require instructor's approval in addition to that given by the Coordinator/Academic Advisor.

Courses from outside the department

Not all graduate departments allow students to enrol in courses via the web. Before attempting to add a course outside your department check with your department and the host department about procedures.

Waiting Lists

Some courses or meeting sections have waiting lists. If the department offering the course has opted to allow a waitlist and either your enrolment category in the course or the course itself is full you can choose to join a waiting list. If sufficient space is opened in your enrolment category, ROSI will automatically place you in the course. It is your responsibility to check the SWS to check on your status. The SWS will inform you of your place on the waiting list and how many spaces are allotted for your category. You may “wait” in multiple meeting sections but if you are enrolled in one meeting section you may not simultaneously wait for another. Your unit may set a limit on the number of waitlisted course in your requests. One day before the final date to enrol in courses all waiting lists will be suspended and normal enrolment procedures will apply. Consult your own unit to find out if you are permitted to join waiting lists. Consult the unit offering the course to see if a waiting list is being used.
Checking course status

Students are responsible for knowing the status of their course requests at all times. This information can be obtained via the web service. The following are the possible statuses:

REQ: Course requested. Must be resolved/approved by the last date to add a course.
INT: Course requested pending instructor approval in addition to Coordinator's/Advisor's approval.
APP: Request approved. Student is enrolled in course.
REF: Request denied. Student is not enrolled and may not make another request for this course via the web during this session.
CAN: Course cancelled (student withdrew from course before deadline)
WAIT: No room in the meeting section. Student has been placed on a waiting list based on category and will be enrolled automatically if space comes available.
DWAIT: Student has cancelled place on the waiting list or been removed.

 Cancelling or withdrawing from courses

Students may cancel or withdraw from individual courses using the web service up to certain deadline dates. Before doing this however, students are advised to consult with their advisor or departmental office. Please note that withdrawing from all your courses does not constitute a withdrawal from your program. To do so, you must complete a Program Withdrawal Form. Dropping courses prior to deadlines or withdrawing from a program without academic penalty does not guarantee a refund.
Information on fee refunds and deadlines is outlined at www.fees.utoronto.ca.

Deadline dates:

August 30: First date students may request courses for the September 2013 and January 2014 sessions. (6:00 a.m. on the SWS)
August 30: Recommended payment or deferral date. Fees should be paid at a chartered bank by this date to allow for funds transfer in time for the September 13 registration deadline. Students not registered by the deadline will have their eligibility and courses cancelled and will not be permitted further access to enrol by the SWS.

**September 15:** *Last date for Mathematics students to request fall and full year courses (F, Y sections) "online" for approval by department.*

September 22: Last date to add fall and full year courses. Students will not be considered enrolled unless they have a course status of "APP".
October 28: Last date to 'cancel' (i.e. withdraw) from a fall (F) course.
January 19: Last date for students to request winter session/second term (S) courses. Courses requiring approval must be cleared with the department before this date.
February 24: Last date to 'cancel' (i.e. withdraw) from a full year (Y) or winter session/second term course.

Final Results

Final grades in courses can be accessed through “Transcripts and Academic History”. Grades can be viewed after the following dates. If a grade is not available, contact your instructor or the graduate unit offering the course.
2013 Summer Session (first term)    July 24
    (full summer and second term)    September 25
2013 Fall Session                  January 15
2014 Winter Session (and Fall/Winter courses)  May 14

**System Availability**

The student web service is normally available at the following times:
Monday       6:00 to 23:45
Tuesday to Thursday  0:15 to 23:45
Friday       0:15 to 18:00
Saturday    midnight to midnight
Sunday      midnight to 23:45

N.B. On the first day of enrolment, the service opens at 6:00.

Occasionally hours must be reduced for system maintenance. Please check the Student Web Service for details.

**URL**
The Student Web Service can be accessed at [www.rosi.utoronto.ca](http://www.rosi.utoronto.ca). Instructions are located there. Please remember to log out after each use.
**APPENDIX F: SGS SESSIONAL DATES 2013-2014**

### Fall Session 2013

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M Aug 5</td>
<td>Civic Holiday (University closed)</td>
</tr>
<tr>
<td>M Aug 12</td>
<td>Registration for fall session begins (9)</td>
</tr>
<tr>
<td></td>
<td>August Undergraduate course enrolment begins (3)</td>
</tr>
<tr>
<td>F Aug 30</td>
<td>Last date for payment of tuition fees to meet registration deadline M</td>
</tr>
<tr>
<td>Sept 2</td>
<td>Labour Day (University closed)</td>
</tr>
<tr>
<td>M Sept 9</td>
<td>Most formal graduate courses and seminars begin in the week of September 9th (2)</td>
</tr>
<tr>
<td>F Sept 13</td>
<td>Coursework must be completed and grades submitted for summer session courses and extended courses (4)</td>
</tr>
<tr>
<td>F Sept 13</td>
<td>Registration for fall session ends; after this date a late registration fee will be assessed M</td>
</tr>
<tr>
<td>Sept 16</td>
<td>Final date to submit final doctoral theses to SGS to avoid fee charges for 2013-14 (3)</td>
</tr>
<tr>
<td>S Sept 22</td>
<td>Final date to add full-year and fall session courses</td>
</tr>
<tr>
<td>W Sept 25</td>
<td>Summer session grades available for viewing by students on the Student Web Service (ROSI) F</td>
</tr>
<tr>
<td>Oct 4</td>
<td>Final date to submit final doctoral thesis for Fall Convocation</td>
</tr>
<tr>
<td>F Oct 4</td>
<td>Final date for receipt of degree recommendations and submission of any required theses for master's degrees for Fall Convocation without fees being charged for the fall session (5)</td>
</tr>
<tr>
<td>M Oct 14</td>
<td>Thanksgiving Day (University closed)</td>
</tr>
<tr>
<td>M Oct 28</td>
<td>Final date to drop fall session full or half courses without academic penalty (7)</td>
</tr>
<tr>
<td>Nov</td>
<td>Fall Convocation information and dates are posted at: <a href="http://www.convocation.utoronto.ca">www.convocation.utoronto.ca</a></td>
</tr>
<tr>
<td>Nov</td>
<td>November pause for Faculty of Arts and Science undergraduate students takes place from November 11th to 12th (6)</td>
</tr>
<tr>
<td>M Dec 23</td>
<td>University closed for winter break from Monday, December 23 to Friday, January 3 inclusive (for last day of classes before Winter break, consult graduate units concerned)</td>
</tr>
</tbody>
</table>

### Winter Session 2014

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M Jan 6</td>
<td>University re-opens</td>
</tr>
<tr>
<td>M Jan 6</td>
<td>Most formal graduate courses and seminars begin in the week of January 6th (2)</td>
</tr>
<tr>
<td>F Jan 10</td>
<td>Final date for registration of students beginning program in winter session; after this date, a late registration fee will be assessed</td>
</tr>
<tr>
<td>F Jan 10</td>
<td>Coursework must be completed and grades submitted for fall session courses (4)</td>
</tr>
<tr>
<td>W Jan 15</td>
<td>Final date to submit doctoral theses without fee payment for winter session</td>
</tr>
<tr>
<td>W Jan 15</td>
<td>Fall session grades available for viewing by students on the Student Web Service (ROSI) S</td>
</tr>
<tr>
<td>Jan 19</td>
<td>Final date to add winter session courses (4)</td>
</tr>
<tr>
<td>F Jan 24</td>
<td>Final date for receipt of degree recommendations and submission of any required theses for March or June graduation for master's students without fees being charged for the winter session (5)</td>
</tr>
<tr>
<td>F Jan 24</td>
<td>Final date for all students to request that their degrees be conferred in absentia in March F</td>
</tr>
<tr>
<td>Jan 24</td>
<td>Final date to submit final doctoral thesis for March convocation in absentia</td>
</tr>
<tr>
<td>F Jan 24</td>
<td>Fall dual registrants must be recommended for the master's degree by this date to maintain their PhD registration (5)</td>
</tr>
<tr>
<td>M Feb 17</td>
<td>Family Day (University closed)</td>
</tr>
<tr>
<td>Feb</td>
<td>Reading Week for Faculty of Arts and Science undergraduate students takes place from February 17th to 21st (6)</td>
</tr>
<tr>
<td>M Feb 24</td>
<td>Final date to drop full-year and winter session courses without academic penalty (7)</td>
</tr>
<tr>
<td>March</td>
<td>March Graduation in absentia Information is posted at: <a href="http://www.convocation.utoronto.ca">www.convocation.utoronto.ca</a></td>
</tr>
<tr>
<td>April</td>
<td>For last day of winter classes, consult unit concerned</td>
</tr>
<tr>
<td>Date</td>
<td>Month</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td>Th Apr 17</td>
<td>For students obtaining degrees at June convocation, course work must be completed and grades submitted for full-year and winter session courses</td>
</tr>
<tr>
<td>Th Apr 17</td>
<td>Final date for receipt of degree recommendations and submission of any required theses for master’s degrees for June convocation</td>
</tr>
<tr>
<td>Th Apr 17</td>
<td>Final date for submission of final doctoral thesis for students whose degrees are to be conferred at the June convocation</td>
</tr>
<tr>
<td>Th Apr 17</td>
<td>Final date for degree recommendations of winter dual registrants for the master's degree to maintain their PhD registration</td>
</tr>
<tr>
<td>F Apr 18</td>
<td>Good Friday (University closed)</td>
</tr>
</tbody>
</table>

**Summer Session 2014**

<table>
<thead>
<tr>
<th>Date</th>
<th>Month</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2</td>
<td>Final date for registration for May session</td>
<td></td>
</tr>
<tr>
<td>May 9</td>
<td>Course work must be completed and grades submitted for full-year and winter session courses (except for extended courses)</td>
<td></td>
</tr>
<tr>
<td>May 11</td>
<td>Final date to enrol in May-June or May-August session courses</td>
<td></td>
</tr>
<tr>
<td>May 14</td>
<td>Winter session grades available for viewing by students on the Student Web Service (ROSI) M</td>
<td></td>
</tr>
<tr>
<td>May 19</td>
<td>Victoria Day (University closed)</td>
<td></td>
</tr>
<tr>
<td>May 30</td>
<td>Final date to drop May-June F section courses without academic penalty</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>June Convocation information and dates are posted at: <a href="http://www.convocation.utoronto.ca">www.convocation.utoronto.ca</a></td>
<td></td>
</tr>
<tr>
<td>June 20</td>
<td>Final date to drop May-August session Y section courses without academic penalty</td>
<td></td>
</tr>
<tr>
<td>June 20</td>
<td>Final date to enrol in July course work only programs</td>
<td></td>
</tr>
<tr>
<td>June 29</td>
<td>Final date to enrol in July-August courses</td>
<td></td>
</tr>
<tr>
<td>July 1</td>
<td>Canada Day Holiday (University closed)</td>
<td></td>
</tr>
<tr>
<td>July 18</td>
<td>Final date to drop July-August S section courses without academic penalty</td>
<td></td>
</tr>
<tr>
<td>July 18</td>
<td>Coursework must be completed and grades submitted for May/June F section courses</td>
<td></td>
</tr>
<tr>
<td>July 23</td>
<td>Grades for May/June F section courses available for viewing by students on the Student Web Service (ROSI)</td>
<td></td>
</tr>
</tbody>
</table>

(1) Graduate students may only enrol in undergraduate courses with the approval of their supervisor or graduate unit. Students are responsible for meeting the deadlines and requirements of the undergraduate course as presented in class and in the undergraduate division’s calendar. Graduate students will be graded under the graduate grading scale. Students should consult the appropriate undergraduate calendar for enrolment and dates.

(2) The precise dates of commencement of courses are determined by the graduate units; students are urged to contact the relevant graduate units for information. SGS maintains the 13-week graduate instruction period; however, if a course does not fall into the traditional 13-week period, the graduate unit will inform students of important dates and deadlines in the course syllabus. University policy states that the first day of classes in the fall session in all teaching divisions should not be scheduled on the first and second days of Rosh Hashanah (from 1 1/2 hours before sunset on Wednesday, September 4, 2013 to about 1 1/2 hours after sunset on Friday, September 6, 2013) or on Yom Kippur (from about 1 1/2 hours before sunset on Friday, September 13, 2013 to about 1 1/2 hours after sunset on Saturday, September 14, 2013).

(3) A final thesis is the corrected, approved version of thesis which is submitted to SGS following the Final Oral Examination.

(4) Graduate units may establish earlier deadlines for completion of course work and may prescribe penalties for late completion of work and for failure to complete work, provided that these penalties are announced at the time the instructor makes known to the class the methods by which student performance shall be evaluated.

(5) For final dates for completing degree requirements, students should consult their own graduate unit.

(6) These are the dates which have been established for undergraduate students in the Faculty of Arts and Science. Not all Faculties offer Reading Week or a November Pause. To find out if your Faculty offers a Reading Week or November Pause, please contact them directly. SGS does not have a Reading Week or November Pause.

(7) Graduate units may establish earlier deadlines to add/drop courses but these dates must clearly be communicated to students. Please note that the last date to cancel a course or registration with no academic penalty is not the same as the
last date to be eligible for a refund.

(8) Students starting their program in the summer and OISE students are required to register by this date by paying the minimum tuition amount stated in their invoice.

(9) Invoices will be available on the SWS (ROSI) by July 15. Most graduate students may make payments, or be eligible to register without payment (i.e. defer their fees), beginning July 15.