Mathematics
UNIVERSITY OF TORONTO

2024-25 Graduate Course Proposals

If you wish to offer a graduate course for possible teaching credit for the 2024-2025 academic year, kindly use this form to enter your submission no later than Friday, January 5, 2024. You are encouraged to discuss with colleagues in your research area the courses you wish to offer as to coordinate the scheduling (fall vs. winter), the topics, and the level (introductory vs. advanced). Thank you.

A. Introduction

1. Name (Last, First) *

Bar-Natan, Dror

2. Course(s) that I would like to teach: Core, Topics, Fields Institute *

- ( ) Core course only
- ( ) Topics course only
- (•) Core and topics
- ( ) Fields only
- ( ) All of the above

3. Core courses that I would like to teach:

- [ ] Real Analysis I (Fall semester)
- [ ] Partial Differential Equations I (Fall semester)
- [x] Algebra I (Fall semester)
- [x] Differential Topology (Fall semester)
- [ ] Mathematical Probability I (Fall semester)
- [ ] Linear Algebra and Optimization (Fall semester)
- [ ] Real Analysis II (Winter semester)
- [ ] Complex Analysis (Winter semester)
- [ ] Partial Differential Equations II (Winter semester)
- [ ] Algebra II (Winter semester)
- [x] Algebraic Topology (Winter semester)
- [ ] Mathematical Probability II (Winter semester)

4. Fields Institute Shared Graduate Courses (If you would like to offer a Fields Institute Shared Graduate Course, please select "Yes". *

- ( ) Yes
- (•) No

5. Detailed course outline for Fields Shared Courses program (Please either copy and paste your detailed course outline here or upload a file below.)

Enter your answer

6. Fields Shared Courses proposal (you can either upload a file here or submit your detailed course outline above.) (Non-anonymous question)

B. Topics courses

Graduate faculty members are invited to offer special courses based on their research interests. Such courses should be accessible to certain groups of students who have no prerequisites other than the core courses.

7. Course(s) Title(s)

12 Definitions of the Alexander Polynomial

8. Course(s) Number(s) (Please see the following link for a list of available numbers: https://sgs.calendar.utoronto.ca/degree/Mathematics). Please let us know if a new course code is needed.

MAT 1350

9. Subject Area

- ○ Algebra & Number Theory
- ○ Analysis & PDE

- ( ) Computational & Applications
- ( ) Operator Theory, Set Theory & Logic
- ( ) Probability, Dynamics & Ergodic Theory
- (•) Topology & Geometry
- ( ) Other

10. Semester

- ( ) Fall 2024
- ( ) Winter 2025
- (•) Either

11. Can this course be cross-listed with a 4th year UG course?

- ( ) Yes
- (•) No
- ( ) Maybe
- ( ) N/A

12. Can this course be offered as a seminar (CR/NCR)?

- (•) Yes
- ( ) No

- ○ Maybe

13. Course level

- ○ Introductory
- ◉ Advanced
- ○ Special topics

14. Detailed course outline (Please either copy and paste your detailed course outline here or upload a file below.)

In math, we often care for things for how well-connected they are. In themselves, 57 and 1729 and 196884 are just members of an infinitely long dull and monotone procession of "numbers". Yet the Theory of Numbers talks to nearly everything in mathematics, and everything talks to it. Knots are likewise dull, and Knot Theory is likewise interesting, and within Knot Theory the Alexander Polynomial plays a special role: it is arguably the most successful "Knot Invariant", it talks to everything, and everything talks to it.

In this class we will cover 12 of the 50 or so definitions of the Alexander Polynomial and discuss how they are related to formal probability and determinants, fundamental groups, and Fox derivatives, homology, covering spaces and finitely presented modules, Seifert surfaces and linking forms, braids and their Burau representation, exterior algebras and the Berezin integral, skein relations, tangles and meta-monoids, finite type invariants and the Kontsevich integral, 2-knots in 4D and the w-expansion and Hopf algebras and algebraic knot theory.

We will aim to implement in Mathematica almost everything that we will talk about, so this class is also about turning sophisticated mathematics into concise and effective code.

Prerequisites: Excellent grasp of everything in Core Algebra I (MAT1100) and in Core Topology (MAT1301), and no fear of computers.

Evaluation: Near-weekly problem sets, a possible full day of student lectures at the end.

15. Detailed course outline (Non-anonymous question ⓘ)

16. Other courses that I am available to teach (Please list them in order of priority):

Core Algebra I, core topology.

17. Comments

Enter your answer