Mathematics 690: Knots and Three-Manifolds

Fall 2014 | Tu, Th 1:25–2:40pm | Physics building 227

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Office hours: TBA, and by appointment (set up in person or by email).

Prerequisites: The course should be accessible to anyone with a basic background in algebraic topology (along the lines of Math 611). I'm hoping that it will be interesting and useful to anyone of an algebraic or topological bent.

Assignments: There will be little (or possibly no) homework for this course, and no exams. Just show up and follow along!

Registration: It looks like you need a permission number to enroll in the course. This is no problem; please just ask me and I'll be happy to give you a permission number.

Course information: Knots play a central role in the modern study of the topology of three-dimensional manifolds. In this graduate topics class, we'll see how knots can be used to construct and understand three-manifolds, and we'll also study the rich algebraic theory of knot invariants, including recent developments that have shaped the field in the past decade.

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Topics I plan to cover include:

- polynomial knot invariants (Alexander, Jones, HOMFLY), skein relations, Vassiliev (finite type) invariants
- braids and their relation to knots: Alexander and Markov theorems, Burau representation, Hecke algebra and the Jones polynomial
- constructing 3-manifolds via knots and Kirby calculus: Heegaard diagrams, Dehn surgery, Kirby moves, and examples
- the Temperley-Lieb algebra and Witten's quantum invariants of 3-manifolds
- Khovanov homology and categorification
- knot Heegaard Floer homology.

I will begin the class loosely following Prasolov and Sossinsky, but will frequently diverge from it.

References: Here are some good reference texts for at least parts of the course. I'll mention more specialized references as we proceed.

- Prasolov and Sossinsky, *Knots, Links, Braids, and 3-Manifolds*
- Rolfsen, *Knots and Links*
- Lickorish, *An Introduction to Knot Theory*
- Murasugi and Kurpita, *A Study of Braids*