Math 4TT3/6TT3

Introduction to Knot Theory

2022 Winter Term

Course Home Page

The course home page is https://ms.mcmaster.ca/~boden/Math4TT3.html

Class times and Locations

Class meets on **Tuesdays and Thursdays, 11:30–1:00pm**. Class times are also available on Mosaic. All lectures will be delivered through the Zoom until the week of February 7 when we return to in-person lectures. The in-person lectures will be given in **HH-312**.

Instructor Hans Boden

office HH/313

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Topics

Knots, knot coloring, invariants of knots. Alexander polynomial, Seifert surfaces. Prime decomposition of knots. The knot group and classification. Jones polynomial, Tait conjectures. Slice knots and concordance. Knots in higher dimensions, other topics as time permits.

Office Hours

These will be posted during the first week of lectures.

Course Description

Introduction to the mathematical theory of knots. Knots occur in many "real life" contexts, including our everyday clothing (e.g., shoelaces, ties), as well as in boating, fishing, horse riding, etc. (e.g., reef knot, square knot, bowline). Knots also appear in art and design going back to antiquity, for instance the interlace patterns of Celtic knots. Knots have important applications in science as well, for instance, DNA is knotted in ways that facilitate its overall functionality.

*One can use mathematical methods in surprising ways in studying knots. This goes back over 100 years to the early work of **Peter Guthrie Tait** on tabulating knots and continues to the present day.*

The objective is to develop the modern mathematical approach to the study of knots. Our focus will be on classical knots in the 3-sphere, but we will also discuss how the same methods can be applied to study knotting in other contexts (links, braids, tangles, knots in higher dimensions, etc). Invariants of knots play a principal role, and we will discuss many different invariants and how they have been used to address open questions in the field.

The invariants can take many different forms (numerical, polynomial, group theoretic, etc.), and they have had profound and transformative effects on the subject. A specific example is the Jones polynomial, which was famously used to solve the Tait conjectures and earned Vaughan Jones a Fields medal in 1990.

*Prerequisite(s): Required: **Math 2R03** (Linear algebra). Recommended but not required: **Math 3GR3** (Groups and Rings) and/or **Math 3T03** (Point-set topology).*

Virtual Course Delivery

To follow and participate in virtual classes it is expected that you have reliable access to the following:

- A computer that meets performance requirements [found here](#).
- An internet connection that is fast enough to stream video.
- Computer accessories that enable class participation, such as a microphone, speakers and webcam when needed.

If you think that you will not be able to meet these requirements, please contact uts@mcmaster.ca as soon as you can. Please visit the [Technology Resources for Students page](#) for detailed requirements. If you use assistive technology or believe that our platforms might be a barrier to participating, please contact [Student Accessibility Services](#), sas@mcmaster.ca, for support.

Textbooks

Main textbook:
- *Knot Theory,* by Charles Livingston, ISSB-10: **0883850273**

Auxiliary books:
- *The Knot Book*, by Colin Adams, ISSB-10: **071672393X**
- *An Introduction to Knot Theory*, by W. B. Raymond Lickorish, ISSB-10: **038798254X**
- *Knot and Links*, by Dale Rolfsen, ISSB-10: **0821834363**

Homework

There will be several homework assignments handed out over the semester. These will be collected and marked.

Independent Project

This will involve picking a topic in knot theory, broadly construed, which you should investigate and write a short report (5–8 pages). In your research, focus on questions like, What are the open problems in that area? What are the main results? Who proved the main results and when were they established? What ideas or mathematical constructions underlie the theory? The final report should be accessible to peer students, and you should prepare to give a short presentation on your topic in class.

Exams

*There will be one **Midterm** and one **final exam**.*

Evaluation

Students will be graded according to the following scheme:

Item	Weight
Assignments	25%
Independent project	25%
Midterm	20%
Final Examination	30%
Total	**100%**

Please note that *late Assignments* will not be accepted!

The *Midterm* will be given in class, and the *Final Exam* will be in take-home format and given during final exam week.

Collaboration in written assignments. Discussions about assignments are allowed and are generally beneficial. However, you must write up solutions of the assignment problems by yourself and in your own words. Copying with minor changes (e.g., with symbols changed or with slightly different wording) from solutions prepared by another person or publication, in whatever format, will be dealt with as an act of plagiarism.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

Excused Absences & Course Missed Work Policy

If you are absent from the university for a minor medical reason, lasting fewer than 3 days, you may report your absence, once per term, without documentation, using the McMaster Student Absence Form. Absences for a longer duration or for other reasons must be reported to your Faculty/Program office, with documentation, and relief from term work may not necessarily be granted. Please note that the MSAF may not be used for term work worth 25% or more, nor can it be used for the final examination. Additional information can be found here.

Please note: when using the McMaster Student Absence Form (MSAF) for this course, please report your absence immediately to Hans Boden, at boden@mcmaster.ca (normally within 2 working days) to confirm the absence.

In the event of such an absence, no makeup test will be given, but your course grade will be re-weighted by increasing the weight of the final examination to compensate for the missed test.

Missed Final Exam

Students who miss the Final Exam for a valid reason may apply to the Office of their Associate Dean of their respective faculty for permission to write a Deferred Final Exam. The student must submit a completed McMaster University Medical Certificate and the completed application for the deferred Final Exam to the Office of the Associate Dean within one week of the Final Examination period.

Marks and Mark Corrections:

As the term progresses, all test marks will be posted on the course website. It is your responsibility to check for errors in the grades before the day of the final exam, and to report any discrepancies to your instructor. *No errors will be corrected unless reported by this time.*

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office *normally within 10 working days* of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

It is your responsibility to understand what constitutes academic dishonesty.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the *Academic Integrity Policy,* located at https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/

The following illustrates only three forms of academic dishonesty:
- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either

directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

Additional information about the Code and netiquette can be found here.

Online Conduct

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms. If you are concerned about your virtual classroom experiences, the Equity and Inclusion Office (EIO) is available to advise and assist students who may be experiencing any equity, accessibility, inclusion, harassment, discrimination or sexual violence concerns. You can reach the EIO at equity@mcmaster.ca. Thank you for joining us in ensuring that our McMaster online communities are spaces where no one feels excluded and everyone is able to enjoy learning together.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

RESEARCH ETHICS - NA

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, and/or McMaster email.