

Math 9508 Topological K-theory (Winter 2022)

Course Outline

1. Course Information

Class hours: MWF 2:30-3:30pm, room TBA

2. Instructor Information

Prof. Matthias Franz
Office: MC 103D
Phone: ext. 86538
Email: mfranz@addwesterndomain

Office hours: TBA

3. Course Syllabus and Delivery Mode

Informally speaking, a vector bundle over a topological space X assigns a vector space to every point x in X in a continuous fashion. An important example is the tangent bundle of a smooth manifold. Topological K-theory is the study of (real or complex) vector bundles on topological spaces. It was initiated by Atiyah and Hirzebruch, following pioneering work by Grothendieck in algebraic geometry. Given any compact topological space X , one constructs out of the vector bundles with base X a ring $K(X)$. This way one obtains a generalized cohomology theory in the sense of Eilenberg-Steenrod. K-theory can be used to prove deep results about the existence of division algebras or the number of linearly independent vector fields on spheres as well as the Atiyah-Singer index theorem.

The aim of this course is to provide an introduction to topological K-theory for graduate students who have no previous knowledge of the subject except for basic set-theoretic topology. Tentative syllabus: vector bundles, operations on vector bundles, operators point of view, principle bundles, definition of K-groups (complex and real), Bott periodicity, equivariant K-theory, multiplicative structure, Thom isomorphism, Chern character, Adams operations, characteristic classes, the J-homomorphism, applications to division algebras and vector fields.

As with any other graduate course in mathematics, there will be an emphasis on mathematical reasoning and proof-writing, which will be practiced through in-class discussion and homework exercises, for instance. Additionally, I want to focus on the ability to read (and understand!) mathematical texts. To practice this, we will sometimes read parts of the textbook together in class. The goal is to increase the students' ability to learn mathematics on their own, outside of the classroom.

Students are expected to attend all classes and to prepare for them by reviewing the material from previous classes, to do the assigned homework and to read in advance the sections of the textbook that we are going to read together in class.

Contingency plan for an in-person class pivoting to 100% online learning

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any remaining assessments will also be conducted online (most likely using Zoom) as determined by the course instructor.

4. Course Materials

We will mostly follow the books by Atiyah and Hatcher.

M. F. Atiyah, K-theory, Benjamin 1967, republished by CRC Press 1994

A. Hatcher, Vector bundles and K-theory, v2.2, 2017, freely available at <http://pi.math.cornell.edu/~hatcher/VBKT/VBpage.html>

D. Husemoller, Fibre bundles, 3rd ed., Springer 1994

M. Karoubi, K-theory, Springer 1978, reprint 2008

E. Park, Complex topological K-theory, Cambridge Univ. Press, 2008
Free online access from within the UWO intranet at <http://doi.org/10.1017/CBO9780511611476>

Students should check OWL (<http://owl.uwo.ca>) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. Students are responsible for checking OWL on a regular basis.

If students need assistance, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

5. Methods of Evaluation

The overall course grade will be calculated as listed below:

20% participation in class
30% midterm (written)
50% final exam (oral)

In case a student misses the midterm for a valid reason, either a make-up exam will be offered or the weight of the midterm will be transferred at the final exam. This happens at the discretion of the instructor.

Accommodated Evaluations

In case of an excused absence for an assignment, the remaining assignments will be reweighted. For the midterm exam, either the final exam will be reweighted or a make-up exam may be offered, at the discretion of the instructor.

6. Accommodation and Accessibility

Accommodation Policies

Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The Academic Accommodation for Students with Disabilities policy can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf

Academic Consideration for Student Absence

Students need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question.

Religious Accommodation

Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance.

Additional information is given in the Western Multicultural Calendar:

<https://multiculturalcalendar.com/ecal/index.php?s=c-univwo>

You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (see http://www.registrar.uwo.ca/examinations/exam_schedule.html).

If a student fails to write a scheduled Special Examination, the date of the next Special Examination (if granted) normally will be the scheduled date for the final exam the next time this course is offered. The maximum course load for that term will be reduced by the credit of the course(s) for which the final examination has been deferred. See Academic Calendar for details (under [Special Examinations](#)).

7. Academic Policies

The website for Registrarial Services is <http://www.registrar.uwo.ca>.

In accordance with policy, <http://www.uwo.ca/its/identity/activatenonstudent.html>, the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at his/her official university address is attended to in a timely manner.

Participants in this course are **not permitted to record the online sessions**, except where recording is an approved accommodation, or the participant has the prior written permission of the instructor.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

For homework assignments using Gradescope, you may directly produce an electronic document, for example by writing (neatly!) on a tablet. If you write on paper, then you need a way to scan your sheets and produce a PDF file. If you don't have access to a scanner, you may use a scanning app for smartphones.

8. Support Services

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Student Accessibility Services (SAS) at (519) 661-2147 if you have any questions regarding accommodations.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being:
<https://www.uwo.ca/se/digital/>.

Learning-skills counsellors at the Student Development Centre (<http://www.sdc.uwo.ca>) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Students who are in emotional/mental distress should refer to Mental Health@Western (http://www.health.uwo.ca/mental_health) for a complete list of options about how to obtain help.