Syllabus: Math 5329/7309
Topology I
(Spring 2024)

January 16, 2024

Commitment to being a good educator

This is a math class. And I will speak, repeatedly, of what it means to be a mathematician. Part of my job this semester is to show you what it is to be a mathematician—in practice, through knowledge, and with confidence.

But let me state the obvious, which is that you are human beings first. And what I care much more about, much more than the math, is that you are able every day to live upright as human beings.

If I am doing anything that prevents you from learning with dignity; if something in your life is preventing you from learning; if not passing this class will delay your life in anyway: these are not problems you have to shoulder alone. If you tell me, I commit to listen, and when I am reasonably able, to act – because it is my mission to help you learn.

So as I commit to being a good educator for each and every one of you, I want you to commit to tell me if I am not being a good educator. Your commitment will make my commitment a lot less empty.

1 Logistics

- Instructor: Hiro Lee Tanaka (you can call me Hiro). If you need to e-mail me, you can search for me on TXST's directory, find me on the department website, or reply to one of the e-mails I've sent you.
- Meeting Times: Mondays and Wednesdays, 6:30 PM - 7:50 PM. Derrick 334.
- Office Hours: Wednesdays, 3:00 PM to 4:00 PM. You can also feel free to e-mail met to set up ad hoc times.

1.1 Check your e-mails

My primary mode of communication with you will be your TX State e-mail. All important e-mails from me will begin the subject line with "[Math 5329/7309]."

1.2 Prerequisite knowledge

I expect you all to be comfortable with:

(i) The basics of proof.

(ii) The standard undergraduate math curriculum, including:

  (a) Multivariable calculus (also known as Calculus III at some schools), and

  (b) The theory of groups (this is part of Abstract Algebra at some schools).

(iii) Point-set topology, which at Texas State is the equivalent of Math 4330[1]. You can go to the following URL for some a complete set of Math 4330 Notes:

http://www.hiroleetanaka.com/pdfs/2023-03-fall-4330-topology-reading-PUBLIC.pdf.

You can also check out the course website for Math 4330 if you wish:

https://www.hiroleetanaka.com/index.php?pageID=2023-4330.

[1]My assumption is that many of us may need a little bit of review. We will review material as we need from time to time.

(iv) Analytical skills such as: What ingredients were needed to complete a proof, were all assumptions used, what were the hypotheses of a proof?

1.3 What are office hours for?

Office hours are for *you*. If you have any questions about class—whether it be logistical, or mathematical—this is your chance to ask me in realtime.

Office hours will be held in-person by default. If it is more convenient for you, you can let join via Zoom so long as you let me know ahead of time. If you join the office hours Zoom, you will be placed in a virtual "waiting room." (This is similar to having to wait outside in the hallway as a professor is having a meeting in their office.) Hang tight. I will let you enter the room eventually. If you think you have been neglected or forgotten during office hours, shoot me an e-mail, too, in case I don't see you in Zoom.

1.4 Grades

Here is the grading rubric:

- Quizzes and homework: 15 to 40 percent
- Writing assignments: 15 to 30 percent
- Final exam/assignment: 30 to 50 percent
- Extra credit: Plenty of opportunities.

Your final letter grade will be based on the above numbers. Note each component of your final grade has a range of possible percent values. The ranges will be used at the end of the semester to try to maximize your percentage grade. So if you for whatever reason did very poorly on your final exam/assignment, I can have it count for only 30 per cent of your final grade, as opposed to 50. Of course, the total percentage of all components must add to 100.

I have not yet decided whether to assign a final exam, a final project, or both. It is most likely that I will assign a final project, rather than a final exam – but this is not yet set in stone.

I will decide the conversion between numerical grades and letter grades after final exams are completed. This is because some exams may turn out to have an unfairly low class average, or we may encounter other systemic issues

with the numbers. For example, last semester, anybody with an 60-or-above final grade got a C in the class, because it was clear that certain problems in the exams were weighed unfairly. However, as a rule of thumb, you should assume that a grade of 70 (or above) is sufficient to get a C in this class.

1.5 Exams

There will be at most one exam in this class:

- Final Exam: Wednesday, May 1. 8:00-10:30 PM.

1.6 Absence/attendance/participation policy

You will not be assessed for your in-class work. Regardless, my expectation is that you will come to class every class. On the other hand, ,ife happens. Please e-mail me beforehand, if possible, to let me know of absences. If you miss a class for whatever reason, e-mail me and let me know why.

1.7 Course outline

Here is a very rough outline of the day-by-day topics. **The actual day-by-day coverage may change**.

Week	Date	Topic	Notes
1	01/15	–	MLK Day (No class)
1	01/17	Introduction	First day of class
2	01/22	Review exercises (Open subsets of $\mathbb{R}^n$)	Hiro not in class (Dr. Hirsch substituting)
2	01/24	Review exercises (Subspaces of $\mathbb{R}^n$ and open covers)	Hiro not in class (Dr. Hirsch substituting)
3	01/29	Review of abelian groups. Homology of spaces and maps, via examples.	
3	01/31	Functoriality of homology. Homeomorphism invariance of homology.	
4	02/05	Homotopies and homotopy equivalence.	
4	02/07	Exact sequences. Mayer-Vietoris.	
5	02/12	Practice with exact sequences.	
5	02/14	Computations: Homology of point, Euclidean spaces, spheres.	
6	02/19	Computations: Homology of surfaces.	
6	02/21	Application: Invariance of domain.	
7	02/26	Review exercises (Quotient spaces)	Hiro not in class
7	02/28	Review exercises (Quotient spaces)	Hiro not in class
8	03/04	Application: Brouwer Fixed Point Theorem.	
8	03/06	Review exercises (Spheres, disks, simplices)	Hiro not in class
9	03/11	–	Spring Break
9	03/13	–	Spring Break

Week	Date	Topic	Notes
10	03/18	CW Complexes	
10	03/20	Example: Real projective spaces	
11	03/25	Example: Complex projective spaces	
11	03/27	Cellular homology	
12	04/01	Chain complexes and their homology. Examples.	
12	04/03	Homology of real and complex projective spaces	
13	04/08	Review exercises (Exact sequences)	Solar Eclipse!
13	04/10	Review exercises (Product spaces, tori)	Hiro not in class
14	04/15	Example: Homology of tori in higher dimensions	
14	04/17	Triangulations of S^2 and of $\mathbb{R}P^2$	
15	04/22	Manifolds and orientability	
15	04/24	Topological data analysis	
16	04/29	Review day	Last day of class
16	05/01	Final Exam (8 PM)	Final Exam (8 PM)

2 Academic Integrity (Hiro's take)

You do not get many chances in life to learn something; it is also rare to get straightforward feedback on what you need to do to improve. Any form of cheating or copying robs you of such chances. To get feedback on someone else's work is useless to you in most cases, and to allow someone else to duplicate your ideas robs that person of a chance to think more on their own, or to get honest feedback about what they need to do to succeed. Add on top of that the potential punitive consequences of being caught—nobody feels good about having to initiate an academic honesty investigation—and you'll find a mountain of disincentives. I expect that you will not rob yourself, or rob others, of the time to think for one's self and the opportunity to receive feedback appropriate to one's particular state.

I also trust in your maturity to distinguish between collaboration and plagiarism. Collaborations are encouraged, should be acknowledged in all work you submit ("I worked with so-and-so."), and must also be mutual (it's not a collaboration unless the other parties agree to it).

Finally, most plagiarism or cheating occurs as a consequence of other factors in your life. Make sure you place yourself in a position to succeed and think. Give yourself time to do homework. Beginning on the night before a due date is often not good enough, because math takes a very long time to think through.

Working both a full-time job and taking four classes takes away this time. I know that life is not flexible, but if possible, you should consult with the financial aid office to explore options for working less or taking fewer classes. (Though, in my personal opinion, every student should be provided the resources to take classes without having to have a full-time job; I am sorry that you are in a system that does not allow for such freedoms.)

2.1 Resources

2.1.1 Your learning matters

It is the University's goal that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, contact the Office of Disability Services as soon as possible at 512.245.3451 to establish reasonable accommodations. (If we are in a physical classroom, please be aware that the accessible table and chairs in a

given classroom should remain available for students who find that standard classroom seating is not usable.)

For more information, see:

`https://www.ods.txstate.edu/faculty-and-staff-resources/resources.html`

If you are having technical difficulties, you can also contact DOIT:

`https://doit.txstate.edu/services/`

2.1.2 Online documents

There are many resources available to you for various course sequences. Make sure to take advantage of them—resources like these are usually not available later in your college careers.

2.1.3 Textbook/Required course materials

We will not use a textbook, but resources and readings are available on the course website for free.

2.2 Course content, Purpose and Objectives

This class is a graduate-level topology class. It will introduce you to interesting examples of topological spaces, and a principal tool for studying spaces in general: Homology.

Beyond a fluency with the above topics, another goal of this class is for you to become familiar with mathematical thinking—questioning and understanding why definitions exist, identifying when you or another communicator is being precise or imprecise (and for what purpose), developing tastes that are rooted in practice and informed experience, exploring the mathematical landscape on your own.