Syllabus

Math 339FM: Rigidity Theory

Spring 2023

Table of contents

I. When and Where

Room: MWF 11:30-12:45, Clapp 420

Instructor: Jessica Sidman

Office: Clapp Lab 402a

Phone: 538-3251

Email: jsidman

Student office hours: These are drop in hours for group and individual discussions. See the calendar for times. If you can't make my office hours, please send me an email letting me know some times you are available to meet and I will choose one that works for both of us.

II. Goals

Why should you care about rigidity theory?

Rigidity theory provides a theoretical framework for analyzing a vast wealth of problems in areas as diverse as sensor networks, computer-aided design, protein folding, architecture, robotics, and engineering.

Learning goals:

Students will be able to

1. Use the data of a framework to confidently make computations to analyze finite and infinitesimal motions.(Level 1)
2. Internalize and understand the major definitions and theorems of rigidity theory (Level 1)
3. Apply definitions and theorems in ways that demonstrate understanding. (Level 2).
4. Write proofs that synthesize multiple concepts and articulate the connections between different proofs within the course context. (Level 3)

Classroom climate goals:

We all need to work together to make the classroom a welcoming and inclusive space where everyone feels that they can learn. I will do my best to listen to each of you and see you for who you really are. We need to recognize that there is a lot we don't know about each other, that we all make assumptions, and that sometimes these assumptions are wrong. We should acknowledge at the outset that we will all make mistakes but that we want to treat each other well so will be open to corrections and suggestions.

Goals for student work: Please come to class ready to share your work and your thinking with the class. The goal is to all engage with the concepts and discuss them. I want you to learn how to make conjectures, to think about how to make abstract definitions to model real world phenomena, to bring theory and computational skills to bear in new contexts, and to gain the persistence and techniques that will stand you in good stead whenever you learn a new and difficult subject. Be ready to listen to what others in the class have to say. Please come on time to class and be ready to participate. This class will be frustrating sometimes. The homework and the class material is challenging but it should not be discouraging. If you get discouraged, the first thing to do is to come see me. Be sure to:

1. Take responsibility for your own learning. I expect you to work to construct your own understanding, with help from course materials, your classmates, and me.
2. Be ready to work hard. Many concepts and problems will be new to you. They will stretch your thinking. You will experience frustration and failure before you experience understanding. This is part of the normal learning process. You will have support on all sides from your classmates and from me.
3. Demonstrate proficiency. Hard work is important, but it's not enough. You must eventually become proficient in the important ideas of abstract algebra and demonstrate this to me. Use everything available to you (your classmates, course materials, and me) to reach this point.

III. What will I need?

Textbook

You will not have to purchase a textbook for this course. I will post course materials (short readings, worksheets, articles, and lecture notes) online.

Technology: Think about your own learning and the others around you if you are using electronic devices in class. Inappropriate uses of technology during class (including texting and looking at websites online) can be distracting to classmates. Please ask permission before taking photos or recording class activities. Any use of technology (including computer software, online videos, websites, etc) on homework assignments should be credited in writing. If use of technology seems to be a problem, we'll have a conversation.

We will sometimes use Matlab and/or Geogebra in class. If you need help with access to a laptop please let me know.

IV. Course work -- what can I expect?

Weekly lesson cycle

Expect a lab, lecture, and an online assignment due on Tuesdays. We'll have quizzes, lecture, and mini-presentations on Thursdays. Homework will be due on Fridays.

What are we going to do in this class?

- **Labs:** Some labs will involve building and manipulating physical structures. Other labs will use computers to perform simulations or calculations. The goal of the labs is to give you physical intuition for the structures we are studying that can help you formulate definitions and conjectures.

- **Theoretical material:** You will see how to use ideas from calculus, linear algebra, and discrete mathematics to analyze physical structures that arise in applications including engineering, computer science, architecture, art, and biology. One of the goals of the course is to allow students to connect ideas from previous classes in order to answer one question: is a framework rigid or flexible?

- **Investigations:** Students will be prompted to think about their learning process and will make the transition from learning from someone to creating their own knowledge. We will model the research process throughout the course. The portfolio is designed to help you think about your learning process and the project is designed to allow you to explore an area of interest.

- **Course structure:** Students should expect frequent (weekly) quizzes and written homework for the first ¾ of the semester. This will give you the opportunity to practice and assess your understanding of the theoretical foundations of rigidity theory. We will decide as a class which applications we want to explore in the last part of the semester, and what we want to do with them. (i.e., read research articles, build structures, computer simulations, etc)

Written homework:

- **Philosophy:** Your goal in completing the assignments should be learning. The best way to learn mathematics is to do it. This doesn't mean that you are expected to complete your homework all by yourself. You are encouraged to start it on your own to see how much you can do alone, but then you should feel free to get help from classmates, tutors, or from me.

- **Tips:** The problems on the written homework will be challenging. You are urged to start working as soon as the problems are posted so that you have plenty of time to discuss the assignment with classmates, tutors, and me.

- **Acknowledgements:** When you write up your assignment we ask two things. First, please acknowledge any help that you received (from written resources, humans, or computers). (You can just write "Help from ..." at the top of the assignment.) It is always appropriate to acknowledge help. Second, you are asked to only write down what you truly believe **you** understand. If something is a little hazy when you're writing it down, then you can let the

grader know that you were a little confused so you can get feedback about that particular point.

- **Grading:** Written assignments are given so that you can practice writing mathematics and receive feedback on your progress. This is an opportunity for you to communicate what you have learned and what you need help understanding. If you would like feedback on particular steps in a problem, then you can indicate this on your assignment.

- **Due dates and late work:** Written homework will be due on Fridays. Late work is discouraged, as it delays the communication of important feedback and results in having to play catch up. Late work will be accepted if a student is willing to have a discussion about why the work is late and how to prevent this in the future. If there is a pattern of late homework or missed quizzes (more than two of either), we will talk about what is going on and determine what credit this work may receive.

Online assignments: Online work will be assigned to help you determine how well you understand the material just covered and to help prepare you for new material. Late work in this category will not be accepted, but extra credit (via forum posts and mini-presentations) is available.

Portfolio

Over the course of the semester you will build a proof portfolio. Portfolio checks are designed to help you reflect on what you have learned, how it fits together, and why it is important.

For each portfolio check you will need to select three homework problems to add to the portfolio.

- One problem should be a computation that you think illustrates an important concept. You will have to explain what it illustrates and why that is important.
- One problem should be a proof that you thought was challenging. You need to explain why it was challenging and what you learned from that challenge that you think might help you later.
- One problem should be a proof that you think is especially important. You need to explain why you think it is important. Does it illustrate a definition? A theorem? A pitfall? Does it make a connection? Complete a story?

The work should be written in LaTex. Please use the template that I've provided. Written work will be graded according to the following rubric:

- Format: (1 point)
    - State your assumptions and goals, and signpost where your work begins and ends.
    - Use equation environments appropriately.
- Writing: (2 points)
    - The work is written in paragraph form.
    - Sentences begin with words.
    - Every computation is contained within a sentence.
- Logic and correctness: (3 points)
    - Work shows understanding of the problem.
    - Relevant details are presented in a correct logical order.

    - Extraneous facts are eliminated.

This is your opportunity to really read your previous work to see if you could make it better now that you are further along in your understanding.

The writing that explains why you chose the problems (as described above) will be given 2 points each graded based on completion as long as your answer is thoughtful. (Example: “It just seemed cool!” will not get credit.)

A portfolio check may include an oral defense where we will discuss one of your portfolio problems without written notes. The grading rubric for an oral defense will be:

- Demonstrate an understanding of the problem statement (1 point)
- Correctly identify relevant definitions, theorems, and computations (1 point)
- Confident and logical presentation of the solution with minimal errors (1 point)

Final project: The goal of the project is for each student to be able to take the theory that we have learned together and connect this knowledge to a topic of individual interest. Each project must include a paper and an oral presentation. A project can have a “making” component in which case the paper may be shorter in length.

V. Grading: Your grade for the course will be determined as follows:

- **Homework and participation:** 35%
- **Quizzes:** 20%
- **Portfolio:** 20%
- **Final project:** 25%

Written homework, online questions, and self-check quizzes (which are not the same as quizzes graded by me) will be given labor-based credit. A meaningful attempt at completing any of these assignments will get full credit. Written homework will include work at all levels. Extra credit in this category can be earned by contributing to our class forum, volunteering to present homework problems in class, or organizing inclusive homework meetings.

Quizzes will assess whether you have internalized definitions and theorems and can work with examples in ways that demonstrate understanding. They are regular snapshots of your progress in Level 1 and 2 work.

The portfolio is an opportunity for you to reflect and deepen your understanding, synthesizing and revising past work. This is part of the Level 3 work for the course.

The project is another opportunity for synthesis and is the other way of demonstrating a Level 3 understanding of the course material.

Overall letter grades will be based on a scale no stricter than the usual:

- 93-100: A
- 90-93: A-
- 88-90 B+
- 83-88: B
- 80-83: B-
- 78-80: C+

- 73-78: C
- 70-73: C-
- 68-70: D+
- 63-67: D
- 60-63: D-
- 0-60: F

VI. Policies

Attendance: If you are healthy, I expect you to come to class. Please come ready to do mathematics. This means that you should bring something to write on and write with and any other equipment that you may need. Before each class you should prepare by doing the assigned reading and online work.

Academic integrity: It is very important for you to follow the Honor Code in all of your work for this course. Collaboration on homework assignments is encouraged. However, it is important that you only write what you understand, and that it is in your own words.

I'm assigning work so that you have the opportunity to grow as a thinker and writer. I want you to play, struggle, and revise. I'll provide lots of opportunities for you to work with peers and with me. If you get help from other sources, please cite them. We will discuss issues related to consulting stackexchange, chegg, or ChatGPT (or similar AI technology) and what constitutes a violation of the honor code. I reserve the right to revise course policies around consultation of emerging technology.

If you have any questions about what constitutes an Honor Code violation in this class please ask your instructor. The deans have asked faculty to report any suspected Honor Code violations.

Video: Please do not make video or audio recordings of class without previous permission from me. If I record some classes I will post the videos to our course moodle site and access will be restricted to our class.

Title IX Mandatory reporting: Under College policy, and in accordance with Title IX, all faculty are considered mandated re- porters. Mandated reporters must promptly report to the Title IX Coordinator when they receive information that could reasonably raise a concern that gender-based or sexual misconduct may have occurred. This includes anything related to sexual assault, sex or gender-based harassment, dating violence and or stalking. The purpose of this disclosure is to ensure that students are made aware of their reporting options and resources for support. For more information about reporting options at Mount Holyoke, including confidential and anonymous reporting options, please visit: https://www.mtholyoke.edu/policies/gender-based-and-sexual-misconduct

VII. Land Acknowledgement

Mount Holyoke College is located in Western Massachusetts on the ancestral land of the Nonotuck people. It is also important to acknowledge the neighboring Indigenous nations who continue to be connected to this land: the Nipmuc and the Wampanoag to the East, the Mohegan and Pequot to the South, the Mohican to the West and the Abenaki to the North.