

Math 333: Abstract Algebra, Fall 2020, taught remotely via Zoom

Instructors: Tarik Aougab (he/him/his)

Office Hours: Will be announced during the second week of class after we get a feel for everyone's schedules and can pick times that work for all. If you'd like to meet during the first week of class, please feel free to email me and we can try to find a time.

Textbook: I will be using *Algebra* by Michael Artin to help plan parts of the lectures, but **there is no required textbook**.

Course Description and objectives: Abstract algebra is a gorgeous topic in mathematics, and loosely speaking, its main focus is the treatment of *symmetry*, which is easily one of the most important topics in all of mathematics. Intuitively, we understand that a circle is “more symmetric” than an ellipse, and that an equilateral triangle is “more symmetric” than a scalene triangle. But mathematically speaking, what does this really mean? To say that one object is “more symmetric” than another implies that we have a way of *quantifying* symmetry- how does this work? The idea of a *group* formally addresses this and many other questions, and will be the central topic of the first third of our course. We will then move on to *rings* and *fields*, algebraic structures that allow a mathematician to explore the concept of symmetry in more abstract contexts that pop up organically all over mathematics.

Growth, not ability: There is a very prevalent belief that you are either “good” or “bad” at math, and if you are “bad” at it, then you will always be bad at it no matter how hard you try. **This is extremely false, and the mathematics community bears a lot of responsibility for perpetuating this myth.** In reality, mathematics is just like any other discipline or skill: you can improve more and more with practice.

We are all capable of growth in mathematics. You should measure your success in this class by how much your understanding of the concepts have improved over the course of the semester. Also, like most things worth doing, math is hard, so you should expect to struggle with the material! When you struggle, you are learning and growing.

Prerequisites: Solid understanding of concepts taught in Math 215.

Course structure:

Lectures (three 50 minute sessions per week): class time will be held in an interactive lecture format with space for questions and conversation. **My goal is to have at least one brief break-out room activity each lecture** to avoid the situation where I'm the only one talking for 50 straight minutes! I want to establish an environment where folks feel comfortable speaking out and participating. Towards this end, **I ask that everyone have their cameras on during lecture so that we can simulate most closely the experience of actually being physically present with one another.**

Discussions: I will be scheduling 3-4 discussion sessions per week- attendance is highly recommended but not mandatory. The idea is to get folks talking together about the concepts in groups that are roughly half the size of our lecture group. These discussions can be a very important component of the learning experience because they give you an opportunity to discuss the week's main ideas in a smaller group setting and to get some additional practice with an instructor on stand-by.

Homework: Mathematical proficiency requires practice, and a lot of it. The concepts we are going to learn aren't easy to grasp and I expect that they will require a good deal

of contemplation outside of class to really understand. So, there will be a lot of homework. **Students should expect to spend at least 6-8 hours a week on outside homework assignments.**

The homework grading scheme reflects the fact that this is in some sense a writing course in as much as it is a course in abstract mathematical concepts. Each homework problem will be graded out of 4 points. Here is a basic rubric:

4 points: A complete and correct solution with no logical gaps, and clear/concise exposition.

3 points: A complete and correct solution with no logical gaps, but the exposition needs work OR a good attempt with clear exposition that would be fully logically correct if some minor details were fixed.

2 points: A good attempt with clear exposition but with a significant logical gap or error in the argument OR a good attempt with some minor logical issues AND the exposition needs work.

1 point: The beginnings of some ideas are present.

0 points: No serious attempt at a solution has been made.

Homework should be submitted online via Moodle as a single PDF document.

Course policies and recommendations for homework:

I strongly encourage students to work together on the homework assignments. Collaboration is an incredibly important aspect of mathematical science and so you should think of the homework assignments as an opportunity to practice the skill of working well with others. **If you do work in a group for the homeworks, you must turn in your own assignment, written in your own words. You must also mention who you worked with on your assignment so that the graders can keep track of who worked with whom.**

Setting up collaborations in the era of COVID: Working collaboratively is one of the many things that have become logistically much more complicated because of the pandemic. So: during the first week of class, I am going to ask for everyone's work schedules and do my best to set up **homework working pods** (that can meet remotely via zoom).

Respecting each other: We are not all coming to this class with the same privileges, resources, time, and knowledge. It's really important to keep this in mind when working with each other on homework assignments and during lecture. **It is our strong belief that as a community, mathematicians and scientists need to do a much better job of making our disciplines more accessible to people of all races, genders (including gender non-conforming folks), sexual identities, and class backgrounds.** While this is a priority for me in the classroom, I do not claim to know how to best honor this commitment, and so **I am very open to feedback from students when it comes to making the course more accessible and inclusive to all identities.**

It's also important to think about how to respect one another when working together on homework assignments. It's not equally easy for all of us to speak up in a large group, and the voices of historically underrepresented/marginalized students are most easily drowned out in group work. So please keep this in mind when working together. Here are some concrete examples of positive collaborative behavior:

- (1) Making sure everyone who wants it has the opportunity to speak frequently. This can mean checking in with each other to make sure everyone is following along and contributing when they have an idea.
- (2) Respecting people's pronouns and other aspects of their identity.
- (3) Making sure that everyone's ideas are acknowledged when writing up the final solution to a problem. When working in groups, solutions often evolve organically; an idea might pop into your head and you may think it's yours and yours alone, but perhaps you only arrived there because of something else that someone already said. Pay attention to what people are saying and try to learn from one another.
- (4) Honoring different types of contributions. In group work, *active listening* can be just as valuable as speaking. If you have ever processed a thought or an idea by talking it out with an attentive friend, you've experienced this truth firsthand. Listening carefully is in and of itself an important and difficult skill. It can involve being silent and creating the space for your partner(s) to say what's on their mind, and it can also involve asking the right insightful question at the right time. Practice listening with your collaborators, and also practice recognizing and appreciating when your collaborators are actively listening to you!

We will do our best to check in with folks periodically during the semester. If at any time in the semester you want to be working in a group but do not have a group of students to work with, please let me know and I will help you find a working group. If at any time in the semester, you find yourself in a group of students for which the above behaviors aren't being practiced and people aren't feeling respected, please let me know that as well.

Grading and exams:

There will be weekly homework assignments, two midterm exams, and one final exam for the course.

- (1) Written Homework: 25 %
- (2) Midterm 1: 25 %
- (3) Midterm 2: 25 %
- (4) Final exam: 25 %

Personally, I am unconvinced that grading has any real pedagogical value. Grading evolved as a means of *credentialing* people - they are used as evidence *after the semester is already over* (and perhaps when someone is applying for a job) that someone has acquired a certain level of mastery. Thus, if they have any use at all (which is questionable), that use occurs once our time together is already over; I do not believe that grades are particularly useful for helping anyone to actually learn the material.

Ideally, higher education would be designed to prioritize only the ideas and the learning, but since that's not the world we live in (yet) I am obligated to evaluate you and to assign grades. **But since its the learning and the growth that I really care about, I will do my best to provide you with lots of opportunities to demonstrate how you've learned as the course progresses, and I will find ways to reflect your efforts in the final grade.** For example:

- The final exam will cover material from both midterms and will roughly be split into thirds, in order to cover the three central topics of the course (groups, rings, fields). The first midterm will focus on groups and the second will focus more heavily on rings. If you perform better on the portion of the final exam that deals with groups than

you did on midterm 1, I will replace your midterm 1 grade with your performance on that part of the final exam. And similarly for the portion of the final exam on rings and midterm 2.

- On both midterms, you will have the opportunity turn in an “exam re-write”: for any problem for which you did not receive full credit, you can submit a revised, polished version of the solution. If you choose to do this, you should also include a paragraph or two explaining what the original mistake was and how you changed your answer to avoid it the second time around. You’ll have the opportunity to gain back all missing points by doing this.
- At two points during the semester, we will have a “show what you know” week. During that week, you’ll have the opportunity to meet with me for 5-10 minutes and demonstrate your understanding of a detailed proof we’ve covered in class. Participants will be eligible for extra credit. I will select the proof and announce it one week beforehand.

Taking care of yourself: Learning this stuff takes time, effort, and focus, which are resources that may not be available to any one of us during this extremely scary time in the world. **Your health and mental well-being is much more important than your performance in this course.** Of course, I understand that the advice “if you have to make a choice between your health and your grade, choose your health” is a bit unfair coming from someone who has power over your transcript and thus over your stress levels. **If you find yourself in a position where you’re unable to apply the amount of time and focus you intended to at the beginning of the semester, I will do everything I can to work with you to set up an alternative course plan.** Please reach out to me and let me know if this describes your situation at any point during the semester.

Please also remember that as an instructor, I am going through this pandemic too. I will do my absolute best to be as present and clear as possible in my interactions with all of you this semester, but there may be times where I’ll be dealing with abnormal amounts of stress, exhaustion, and even grief. My hope is that especially now, we can keep at the forefront of our minds that we are all human beings first and mathematicians second. So, just as patience is required from me when thinking about how to lead this course and evaluate all of you, it would be great if you could also extend that patience towards me!

Resources: Haverford College is committed to supporting the learning process for all students. Please contact one or both of us as soon as possible if you are having difficulties in the course. There are also many resources on campus available to you as a student, including the Office of Academic Resources (<https://www.haverford.edu/oar/>) and the Office of Access and Disability Services (<https://www.haverford.edu/access-and-disability-services/>). If you think you may need accommodations because of a disability, you should contact Access and Disability Services (athc-ads@haverford.edu). If you have already been approved to receive academic accommodations and would like to request accommodations in this course because of a disability, please meet with one of us privately at the beginning of the semester (ideally within the first two weeks) with your verification letter.