Math 4803: Introduction to Geometric Group Theory
Georgia Tech, Spring 2021

Instructor

Dan Margalit <margalit@math.gatech.edu>

Lecture

Tuesday and Thursday, 3:30-4:45 EST on Microsoft Teams

Web site

http://people.math.gatech.edu/~dmargalit7/classes/math4803/

Office hours

To be announced on the course web site.

Textbook

Groups, Graphs, and Trees by John Meier.

Pre-requisites

Math 4107: Abstract Algebra I and Math 2106: Foundations of Mathematical Proof or equivalent.

Synopsis

Geometric group theory is concerned with the interplay between groups and the spaces that they act on. Every group is the collection of symmetries of a geometric object and vice versa. We use this correspondence to translate information back and forth between the groups and the geometric objects. A typical theorem in the subject is: if a group acts by symmetries on a tree without fixed points, then the group is a free group.

In this course we will encounter many interesting examples of infinite groups, such as the lamplighter group, the braid group, and linear groups. We will aim to understand their basic aspects, such as generating sets and presentations, and we will do so by considering them as symmetries of geometric objects.

Learning outcomes

By the end of this course, it is expected that students will be able to the following:

- apply theory to solve concrete problems in geometric group theory,
- integrate their use of various tools in geometric group theory,
- construct sound mathematical arguments in geometric group theory,
- express mathematical arguments in geometric group theory through written and oral expression.

Canvas

The instructor will use Canvas on a limited basis to distribute information, conduct anonymous course surveys, post grades, etc. Students may communicate with the instructor through Canvas, but direct emails will receive a faster response than a Canvas message.

Piazza, Polls, and Participation

Piazza will be available as a resource for students to ask questions about the course and to respond to each other's questions. Questions that pertain to the class as a whole, should be posted on Piazza, and not asked by email.

Polls will be taken during class using Piazza. Polls will be graded for participation, not correctness. Each poll question is worth 1 point.

Homework and Gradescope

Homework will be assigned approximately weekly. The assignments will be posted on the course web site by the end of the last class of each week, and will be due by the start of the first class of the following week. Homework will be submitted via Gradescope; the entry code is YVDNE8. Late homework will not be accepted, except under extreme circumstances. Students are strongly encouraged to collaborate on homework, but must write their solutions independently (it will be helpful to the graders to report any collaborations). The final homework question each week is to explain a specific definition, theorem, or example (of the instructor's choosing) from the following week's reading.

Midterm

There will be a "take-home midterm" in the first week of March. This will take the place of the usual homework assignment, and will be due at the start of class on March 9. This exam is open book and open notes, but no collaborations, internet searches, or other outside assistance is allowed. The exam will be submitted on Gradescope.

Final project

Groups of 2-3 students will research a topic that builds on the topics covered in class. The topic will be chosen in consultation with the instructor. A good source of ideas is the book *Office hours with a geometric group theorist*. Each group will write a 4-8 page paper on their research topic and give a short presentation to the class on the research. This project will give students a chance to explore an area that is related to the course and that they find interesting. The final draft of the paper will be due by the start of class on April 27.
The final project has the following check points:

- February 4: Topic and group chosen
- February 25: Abstract due
- March 25: Draft of final project due

Further details about the project and its assessment will be made available on the course web site.

Statement of Inclusivity

We are not all coming to this class with the same privileges, resources, time, and knowledge. It is important to keep this in mind when working with each other on homework assignments and during lecture. As a community, mathematicians and scientists must strive to make our disciplines more accessible to people of all races, genders (including gender non-conforming individuals), sexual identities, and class backgrounds. While this is a priority for us in the classroom, we do not claim to know how to best honor this commitment, and so we are open to feedback from students when it comes to making the course more accessible and inclusive to all identities.

The Honor Code and Academic Dishonesty

Abide by the honor code at all times. See http://honor.gatech.edu and here.

Any evidence of cheating or other violations of the Georgia Tech Honor Code will be submitted directly to the Office of Student Integrity. Cheating includes, but is not limited to:
1. Copying directly from any source, including friends, classmates, tutors, internet sources.
2. Allowing another person to copy your work.
3. Taking an exam in someone else's name, or having someone else take an exam in your name.

Students with Disabilities and/or in need of Special Accommodations

Georgia Tech complies with the regulations of the Americans with Disabilities Act of 1990 and offers accommodations to students with disabilities. If you are in need of classroom or testing accommodations, please make an appointment with the Office of Disability Services to discuss the appropriate procedures. More information is available on their website. Please also make an appointment with the instructor to discuss your accommodation, if necessary.

Missed and late work policy

Students may only receive extensions/excuses for homework, polls, midterms, and projects for university-approved absences, religious holidays, illness, and other emergencies. Students should notify the instructor of any such conflicts as soon as they are able.

Grading scheme

The components of the class are weighted as follows:

- 10% Participation (three lowest scores dropped)
- 30% Homework (lowest score dropped)
- 30% Midterm
- 30% Final project

If 85% of the students complete the CIOS course evaluations, then an additional homework will be dropped.

Grade assignments

After *all* grades are in and all overall percentage scores for students have been computed using the weights described above, grades are assigned. The standard cutoffs are as follows.

A: [90%, 100%] B: [80%, 90%) C: [70%, 80%) D: [60%, 70%) F: [0%, 60%)

These cutoffs *might* be adjusted, but only in the downward direction (to make letter grades higher). In the event of a curve, only your final overall percentage grade for the course will be curved. Individual quizzes and exams will not be curved as we go along.

Etiquette

In lecture, students are encouraged to show courtesy to their fellow classmates and instructor by adhering to the following class rules: unless otherwise directed, turning off all apps except the meeting application, a note taking application, and any other application you are using for course work. It is also polite and helpful to come to class on time, turn on video if possible, and stay for the entire period, and stay actively involved by paying attention and asking questions when you have them.

Growth, Not ability

There is a very prevalent belief that you are either "good" or "bad" at math, or somewhere in between, and if you are at a certain level, then you will always be at that level no matter how hard you try. This is 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 (think of any hobby you got better at over time).

We are all capable of growth in mathematics. You should measure your success in this class by how much your understanding of the concepts has improved over the course of the semester. Also, math is very hard, so you should expect to struggle with the material! When you struggle, you are learning and growing. If you find that you are not struggling at all, this might not be the right course for you and you should consider a more advanced course.

Georgia Tech Resources for Personal Support

The Office of the Dean of Students: 404-894-6367; Smithgall Student Services Building 2nd floor. You also may request assistance here.

Counseling Center: 404-894-2575; Smithgall Student Services Building 2nd floor
Services include short-term individual counseling, group counseling, couples counseling, testing and assessment, referral services, and crisis intervention. Their website also includes links to state and national resources. Students in crisis may walk in during business hours (8am-5pm, Monday through Friday) or contact the counselor on call after hours at 404-894-2204.

Students' Temporary Assistance and Resources (STAR) Can assist with interview clothing, food, and housing needs.

Stamps Health Services: 404-894-1420; Primary care, pharmacy, women's health, psychiatry, immunization and allergy, health promotion, and nutrition

OMED: Educational Services

Women's Resource Center: 404-385-0230

LGBTQIA Resource Center: 404-385-2679

Veteran's Resource Center: 404-385-2067

Georgia Tech Police: 404-894-2500

Respecting each other

It is important to think about how to respect one another when working together in study group and on homework assignments. It is 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.

The instructor will do his best to check in with you 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 him know and he 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 him know as well.

Acknowledgment. Parts of this syllabus, in particular the parts about respect and inclusivity, are either copied or adapted from a syllabus written by Tarik Aougab at Haverford College.