Department of Mathematical and Statistical Sciences
College of Science
Clemson University

MATH 4120-001, Modern Algebra
Fall 2019
MWF 10:10–11:00am
Sirine Hall, Room 118

Instructor: Matthew Macauley, Associate Professor.

Contact: Martin Hall, Room O-325; macaule@clemson.edu; 656-1838 (no voicemail).

Office hours: MWF 8:55–9:55am, or by appointment (see details below).

Course website: We will rarely use Canvas. All of the course material will be made freely available on the course website:

`http://www.math.clemson.edu/~macaule/classes/f19_math4120/`

Course Description: Group theory is the study of symmetry, and is one of the most beautiful areas in all of mathematics. It arises in puzzles, visual arts, music, nature, the physical and life sciences, computer science, cryptography, and of course, all throughout mathematics. This course will cover the basic concepts of group theory, with a special effort made to emphasize the intuition behind the concepts and motivate the subject matter. It will also cover basic Galois theory and ring theory, which are more advanced topics.

Many pictures and diagrams will be provided. We will analyze art freises, chemical molecules, wallpaper patterns, and braids. At the end of the semester, you will truly understand groups, rings, fields, subgroups, cosets, ideals, products and quotients, homomorphisms, group actions, conjugacy classes, centralizers, normalizers, semidirect products, theorems by Lagrange, Cayley, Cauchy, and Sylow, and what Évariste Galois stayed up until dawn writing the night before his untimely death in a duel at age 20, that remains one of the most celebrated achievements in all of mathematics.

In the end, you will leave with a new appreciation of the beauty (and difficulty) of an area of mathematics you never dreamt existed.

Prerequisite: Math 3110 (Linear Algebra) and Math 3190 (Introduction to Proofs).

Textbooks: As a first generation college student, I am acutely aware of the struggle that many students face due to overly expensive course materials, and I do my best to support (freely available) *Open Educational Resources*.

This course was designed around the delightfully wonderful 2009 book *Visual Group Theory*, by Nathan Carter. I will not require this for two reasons: (i) it costs $75, (ii) it was written for a more general audience, and so it is not rigorous enough for advanced math majors. However, I strongly recommended getting it if you can.

There is a freely available set of *Inquiry Based Learning* (IBL) lecture notes called *An Inquiry-Based Approach to Abstract Algebra*, by Dana C. Ernst. This follows the Visual Group Theory approach, and is available at

`http://danaernst.com/teaching/mat411f16/materials/`

in pdf form, both the entire e-book and the individual chapters. The IBL style means that the proofs are not included, as they are intended to be filled in by the students. However, it is still a very good reference.

The more traditional book *Abstract Algebra: Theory and Applications* by Tom Judson is also a good reference, and is freely available online.

A complete set of my lectures note slides will be posted on the course webpage. These, along with the book by Judson and the e-Book by Ernst, should more than suffice for resources.

Homework: There will be weekly homework assignments posted on the course webpage. Assignments must be turned in by 4pm on their due date, and *in person* (i.e., not by email). Assignments that are typeset with LaTeX will get an automatic 24-hour extension, unless the due date is Friday. Late assignments will NOT be accepted, so plan ahead!

Quizzes: There will be a number of short quizzes. Some will be announced and others will be spontaneous. I will drop your lowest 2 quiz grades. To encourage you to stay at home and rest if you're sick, I will drop an additional quiz grade if you miss one. *Because of this, there will be no make-up quizzes.*

Exams: There will be 2 in-class midterm exams, and one final exam. I will drop either your lowest midterm or one-half the final exam's weight. All exams will be closed notes and closed book.

Office Hours & Communication Strategy:

My "official" office hours are between my MWF 8am and 10am classes. However, I am around *a lot* more often than that. I am on campus almost every day and my door is usually open when I am in my office. You are welcome to stop by anytime, though I do have sporadic meetings, seminars, etc. Alternatively, you can email me for an appointment. If you send me an email with a block of available times, I will pick from one of those and put in on my Google calendar.

Email is the best way to reach me. I have not set up voicemail on my phone. The best use of a phone call is as a quick way to see if I'm in my office, in case you're thinking of stopping by.

Though I have the Gmail app, I do not get email notifications on my phone. However, I check it multiple times a day. *If you send me an email and I do not get back to you within 24 hours, please re-send it again as a reminder* – just click "Reply", then "Send"; no need to add any more text. The most common explanation for such a lapse is an email that requires a thoughful response that gets put aside, and then buried in my inbox. Emails sent after 9pm may not get replies until the next day. Also, sometimes I don't check email on Saturdays.

Attendance: Please make an effort to attend all classes, and to be on time. I will try to show up at least 10 minutes early to all classes. In the unlikely scenario that I am absent 5 minutes after class has started, check your email. If you have not heard from me 10 minutes after class has begun, you may assume that class has been canceled.

Academic continuity plan: If class is canceled due to celestial powers (e.g., hurricane, snow day, power outage, football), I will assign YouTube lecture(s) from my online course as a make-up.

Technology in class: One particular study on multitasking showed that students on laptops score 11% lower than those not on laptops. Morever, students who were not on laptops but had a laptop in their "line of sight" scored *17% lower!* Therefore, the use of laptops and cell phone in class will not be allowed. Tablets may be used *only* for taking notes, and must be in Airplane Mode.

Grading: Your final grade will be computed as follows:

Homework	25%
Quizzes	15%
Midterm 1	20%
Midterm 2	20%
Cumulative Final Exam	40%

I will drop either your lowest midterm grade, OR half the weight of your final exam; whichever is lowest. I also have the following "final exam policies," though *they only apply if you have a passing grade on the homework*: If you get at least 80% on the final exam, then you will get an A in the course. If you get at least 60% on the final exam, then you will get (at least) a B in the course.

I do not impose arbitrary numeric cutoff lines for final grades, e.g., A=90+, B=80–89, etc. Rather, I grade by natural "clusters." I tend to give difficult assignments and exams, and so the letter grades end up corresponding to lower numeric averages than they do in most classes.

Make-Up Policy: No make-up exams will be given. I will drop your lowest midterm, which means that if you miss a midterm, then your final exam grade will replace it. The homework deadlines will not be extended for individual students, and assigned homework must be turned in by the deadline.

Student Learning Outcomes: Upon successful completion of the course, students will be able to

Demonstrate a solid understanding of modern algebra (group theory, ring theory, and Galois theory) at the undergradate level.

Explain to a friend or family member who knows nothing about mathematics what group theory is, how it arises, and why it's beautiful.

Explain how group theory can be thought of as the study of symmetry, and how it arises in puzzles, visual arts, the sciences, and other brances of mathematics.

Use visual diagrams and pictures to demonstrate the important definitions and concepts of group theory (of course, in addition to being able to define them rigorously).

Learn to understand, read, and write rigorous mathematical arguments on topics in algebra.

Develop good mathematical writing skills. Important aspects of this are *accuracy*, *clarity*, and *conciseness*.

Key Dates

Aug 21 (Wed)	Classes begin; late enrollment fee applies
Aug 27 (Tues)	Last day to register or add a class
Sep 3 (Tue)	Last day to drop a class or withdrawfrom the University without a W grade
Oct 14-15 (M-Tu)	Fall break
Oct 29 (Tue)	Last day to drop a class or withdraw from the University without final grades
Nov 27-29 (W-Fr)	Fall break
Dec 6 (Fri)	Last day of class
Dec 10 (Tue)	Final Exam, 3:00–5:30pm
Dec 19 (Thu)	Graduation

Social media: If you want to connect with me on Social Media, then use LinkedIn. I will not accept friend requests on Facebook, there is just too much potential for risk and liability.

Academic Integrity: "As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning'. Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

Special Accommodations: Students with disabilities who need accommodations should make an appointment with Dr. Arlene Stewart, Director of Disability Services, to discuss specific needs within the first week of classes. Students should present a Faculty Accommodation Letter from Student Disability Services when they meet with instructors. Student Disability Services is located in Suite 239 Academic Success Building (656-6848; sds-l@clemson.edu). Please be aware that accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Title IX: Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veterans status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. The policy is located at `http://www.clemson.edu/campus-life/campus-services/access/non-discrimination-policy.html`. Alesia Smith serves as Clemsons Title IX Coordinator and may be reached at alesias@clemson.edu or (864) 656-3181.

Copyright Statement: Some of the materials in this course are possibly copyrighted. They are intended for use only by students registered and enrolled in this course and only for instructional activities associated with and for the duration of the course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the Teach Act. Refer to the Use of Copyrighted Materials and "Fair Use Guidelines" policy on the Clemson University website for additional information: http://clemson.libguides.com/copyright