

Math 3140 (Fall 2012): Abstract algebra

Jonathan Wise

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1 Office hours and contact information

Instructor	Jonathan Wise
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Office hours (provisional!)	MWF, 3–4pm

2 Prerequisites

The course prerequisites are Math 2001 (Introduction to Discrete Mathematics) and Math 3130 (Linear Algebra) or equivalent background. **These prerequisites are essential!** If your memory of these prerequisites is hazy, you should review the material from those courses on your own time. **We will rely, often and heavily, on these concepts in this class!**

3 Syllabus

The motivating problem for this course is the following:

Given a polynomial equation $x^5 + ax^4 + bx^3 + cx^2 + dx + e = 0$ with rational coefficients, is it possible to express the solutions to this equation using only the operations of addition, subtraction, multiplication, and the extraction of roots?

This problem was first solved in general in the early 19th century, the culmination of work by many mathematicians. In this class we will tour the algebraic structures that go into the solution of this problem, beginning with the study of abstract symmetry (group theory) and continuing through . We will finish the class with a discussion of the solution (the rigor of this discussion will depend on how much material we cover).

Introductory algebra has three main topics:

- Groups. Group theory is the study of symmetry: the set of symmetries of anything—a geometric object, a vector space, a set—always come with what is called a group structure. We will begin the course by investigating this structure and then move on to study groups abstractly.

- Rings. Rings are generalizations of the integers: they are sets where elements can be added, subtracted, and multiplied. You are likely already familiar with a number of rings: in addition to the integers, we have the rational numbers, the real numbers, the complex numbers, and polynomial rings. We will become acquainted with many others and study their basic properties.
- Fields. Fields are rings in which it is also possible to divide. Three of the rings listed above are actually fields. Rings and group theory collide in the study of the symmetries of fields, a subject known as Galois theory, which is the fundamental tool in the solution of the problem posed at the beginning of this section.

We will spend essentially half of the course on groups and half on rings (including fields).

4 Textbook

The primary textbook for this course is

J. B. Fraleigh. *A first course in abstract algebra*, seventh edition. Addison Wesley. ISBN-10: 0201763907. ISBN-13: 978-0201763904.

Please note, however, that not all course material will be drawn from this textbook. Some will be given as course notes (on the course webpage) and some may be discussed only in class. Unless you are explicitly told otherwise, you will be responsible for all such materials on the homework and exams.

There are many reasonable introductions to abstract algebra available, and I recommend looking beyond the official textbook for other perspectives. I will also be consulting the following books as I prepare the course:

M. A. Armstrong. *Groups and symmetry*. Springer. ISBN-10: 144193085X. ISBN-13: 978-1441930859.

M. Artin. *Algebra*, second edition. Prentice Hall. ISBN-10: 0132413779. ISBN-13: 978-0132413770.

D. S. Dummit and R. M. Foote. *Abstract algebra*. Wiley. ISBN-10: 0471433349. ISBN-13: 978-0471433347.

I will suggest other references whenever I feel they are appropriate, but you will be able to turn up many more searching or by spending some time in the library.

5 Homework

In general, **homework will be due on Mondays**. Since Monday 9/3 is a holiday, the first assignment is due on Wednesday, 9/5.

Unless I specify otherwise, you are free—and encouraged—to work together and to use outside resources on your assignments. However, **you must cite any resources you use**, including both texts you consulted (this also refers to resources on the internet) and people with whom you discussed the assignment. If you work with others on an assignment, **be sure to write up your solutions alone**: this way you will get all of the benefits of

collaboration but also ensure that you understand every step of what is written on your paper. Unless you are explicitly permitted to turn in assignments as a group, **do not write up solutions while discussing the problems with others**: this invariably leads to situations where a student submits a solution that he does not completely understand himself.

I recommend approaching homework assignments in the following sort of way: First, spend some time thinking about the problems yourself; identify the parts that seem easy and those that seem hard. Then discuss the problems with one to three other students. Destroy your notes when you end your discussion and then go home to write your solutions independently.

You will find that solutions to many of the problems on your assignments can be found online or in the library. However, you will get more out of your homework if you make a genuine effort to solve the problems yourself before consulting outside resources. That said, you should also balance the impulse to solve every problem yourself against your time constraints: if you are really stuck on a problem, seek out a hint—from me, from a classmate, from a textbook, or from the internet—and keep trying. And remember to cite the hint when you turn in your assignment.

6 Exams and grading

There will be one in-class mid-term exam, one take-home mid-term exam, and one take-home final (in that order).

Your final grade will break down as follows:

30%	Homework	
20%	Exam 1	in class Oct. 3
20%	Exam 2	due Nov. 16
30%	Final	due Dec. 18

These dates are provisional. I'm willing to reschedule if there is a general desire to do so.

7 Conflicts, issues, rules and regulations

If any conflicts or other issues come up, or you feel uncomfortable in class for any reason—academic or otherwise—please let me know. I will do what I can to resolve the issue. Some of the things that come up most frequently are conflicts due to religious observance, accommodations for disabilities, and requests to be addressed by a different name or pronoun. I hope you will feel comfortable coming to me if these or any other issues arise.

The earlier you come to me, the easier it will be for me to help. I won't ask for specific information about your request unless it is necessary.

You can read more about the official university policies on these and related topics here:

www.colorado.edu/ememoarc/faculty/2012.08/0002.html

Of course, those policies will be respected in this course. Please note that in order to provide special accommodations for a disability I will need to have a letter from disability services explaining what accommodations are appropriate. This letter may take time to procure, so please contact Disability Services early if you may qualify for special accommodations.