

Math 206B: Algebra

Winter 2021

Course Information and Syllabus

Professor: Nathan Kaplan, nckaplan@math.uci.edu

Zoom Office Hours: Monday, Thursday, 2:00 - 2:50 PM.

If you would like to meet with me at a different time, send me an email and I am happy to find something that works.

TAs: Alex Sutherland, asuther1@uci.edu,

Office Hours: Tuesday 2:00-3:00PM and Friday 10:00-10:50AM.

Discussion Sections: Alex will lead Discussion sections on Zoom from 2:00-2:50 PM Wednesdays. Discussion is not required, but you are highly encouraged to attend!

Course Website: <https://canvas.eee.uci.edu/courses/33893>.

Please check your email address on file with <https://eee.uci.edu> regularly.

Introduction

Welcome to Math 206B online! This course will closely follow the structure of Math 206A from Fall 2020. Even though we all now have a little more experience with remote learning, I recognize that this is still a challenge. I am going to continue to try my best to be really flexible and understanding about all the different stuff that people are dealing with right now. I am here to help you get as much as you can out of this remote quarter. If there are issues that come up throughout the course that are making things difficult, please let me know and I will do what I can to help.

Course Goals

Algebra is one of the fundamental areas of mathematics and plays an important role in almost every area of modern mathematics. The goal of the Math 206 sequence is to provide a broad overview of algebra and to give you with a strong foundation that prepares you to pursue more advanced topics in the future. You will develop your algebraic intuition by working with many examples, solving lots of problems, and doing many proofs. Another key goal of this course, particularly for graduate students, is to prepare you for success on the Comprehensive Exam and Qualifying Exam in Algebra.

$$\begin{pmatrix} \lambda & 1 & & & \\ & \lambda & \ddots & & \\ & & \ddots & 1 & \\ & & & \lambda & 1 \\ & & & & \lambda \end{pmatrix} \quad \begin{array}{ccc} M \times N & \xrightarrow{\iota} & M \otimes_R N \\ & \searrow \varphi & \downarrow \Phi \\ & & L \end{array} \quad \begin{array}{l} a = q_0 b + r_0 \\ b = q_1 r_0 + r_1 \\ r_0 = q_2 r_1 + r_2 \\ \vdots \\ r_{n-2} = q_n r_{n-1} + r_n \\ r_{n-1} = q_{n+1} r_n \end{array} \quad \begin{pmatrix} 0 & 0 & \dots & \dots & \dots & -b_0 \\ 1 & 0 & \dots & \dots & \dots & -b_1 \\ 0 & 1 & \dots & \dots & \dots & -b_2 \\ 0 & 0 & \ddots & & & \vdots \\ \vdots & \vdots & & \ddots & & \vdots \\ 0 & 0 & \dots & \dots & 1 & -b_{k-1} \end{pmatrix}$$

Textbook: *Abstract Algebra, Third Edition*, D. Dummit and R. Foote. ISBN: 978-0-471-4334-7

Course Plan

Here is a description of how I would like this class to work:

1. **Lecture Videos:** My plan is to cover the same material that I would in a traditional lecture format, but to break it up into pieces– I know nobody wants to sit and watch 50 minutes of an online math lecture all at once! Each lecture will consist of several 5-20 minute videos. Most videos will be around 10 minutes and there will usually be 3 or 4 per ‘lecture’. There will typically be 3 or 4 ‘lectures’ posted per week, around 30 for the entire course.
2. **Office Hours:** On Mondays and Thursdays from 2:00 - 2:50 PM, I will host Office Hours using Zoom. I received some feedback last quarter that office hours were not as useful as they could have been. This quarter I would like to try to make office hours more structured. If you have questions you would like me to talk about or problems you would like me to go over, please email them to me or post them on the course Discussion Board at least a few hours before our meeting.

Just like last quarter, these sessions are not required and I am not planning to record them. Alex will also have weekly office hours that will run in a similar style.
3. **Discussion Sections:** Alex will run discussion sections on Zoom every Wednesday from 2:00-2:50PM. Discussion sessions are a very important part of this course. It is a good opportunity for you to practice working through problems on your own and in small groups.
4. **Exams:** There will be two midterm exams and one final exam. One of the big goals of this course is to prepare students for a high-stakes timed algebra exam (the Comprehensive and Qualifying Exams). I feel that the best way to prepare for this kind of exam is to take some timed algebra exams. Just like last quarter, exams will be given online as Canvas quizzes and will require Respondus LockDown Browser and Respondus Monitor.
5. **Canvas Discussion Board:** Last quarter the Canvas Discussion Board was not so active. I would like to continue to use the Discussion Board this quarter, but I will not post a new Discussion Topic for each lecture.

This quarter I will create a Discussion topic specifically for questions about Homework problems and problems from old Comprehensive and Qualifying Exams. In Math 206A, I received lots of good questions about Homework and Comp/Qual questions by email. This quarter I would prefer to try to answer more of these on the Discussion board so that everyone can benefit from seeing the questions and answers.

In Math 206B we will follow Dummit and Foote more closely than we did in Math 206A. That is, we will not have big sections of the course where we are using some other set of notes as our primary reference. On the other hand, there are also more parts of the textbook that we will skip over or only cover briefly.

Major Topics

1. Ring Theory (Sections 7.5, 7.6, Chapter 8, and Chapter 9 (Except for Section 9.6))
 - We will follow the textbook quite closely for this first part of the course. We will first cover the two remaining sections in Chapter 7. We will then discuss Euclidean Domains, Principal Ideal Domains, and Unique Factorization Domains following Chapter 8. We will then focus on Polynomial Rings following Chapter 9.
2. Introduction to Modules (Sections 10.1–10.3).
 - We will give an overview of the theory of modules following the first part of Chapter 10. We will give a condensed discussion of Tensor Products following a combination of Section 10.4 and notes by Keith Conrad.
<https://kconrad.math.uconn.edu/math5211s13/handouts/tensorprod.pdf>.
3. The Classification of Modules over a Principal Ideal Domain and Abstract Linear Algebra.
 - We will cover Sections 11.1-11.2 in detail, but will only briefly discuss the rest of Chapter 11 closely. We will discuss the classification of modules over a PID following Section 12.1.

Important Dates

- Friday, Jan. 29, 2:00-3:30PM: Midterm Exam 1.
- Friday, Feb. 26, 2:00-3:30PM: Midterm Exam 2.
- Thursday, Mar. 18th, 1:30-3:30PM: Final Exam.

Grading

- Weekly Homework: 30%
- Midterm 1: 20%
- Midterm 2: 20%
- Final Exam: 30%

Makeup Exams: Only in extreme circumstances will make-up exams be offered. If an emergency causes you to miss an exam, let me know as soon as possible. In such cases, I will most likely re-weight the other exams rather than offering a make-up exam.

If you would like to take an exam at a different time, please send me an email as soon as possible. For example, if the exam is at a time that does not work well for the time zone that you are in, I am happy to work with you to find a time that works better.

Homework

Weekly homework will be a big part of this course. The best way to become comfortable with a new and challenging subject is to do lots of problems. In particular, we will do many of the problems from recent UCI Comprehensive Exams and Qualifying Exams. You can find a large number of these exams here: <https://www.math.uci.edu/graduate/current-students/examinations>

I have always found that I think better about mathematics when I can discuss it with others and that I only really understand a problem when I can explain its solution to somebody else. You are strongly encouraged to work together on problem sets. I know that it may be harder to develop these kinds of study groups with the remote format, but I definitely recommend that you find a way to work together with others. I highly encourage you to solve problems together with others, but you should **write up your solutions individually**.

Dummit and Foote has a ton of great exercises and most of the homework will come from the textbook. I know that there are lots of documents online giving solutions to problems from the book. I'm not saying that you are not allowed to look at these, but if you use outside sources (other textbooks, websites, etc.) for your homework, you **must acknowledge them**. If you do not take the homework seriously (if you just copy solutions from a website), then you won't learn anything from it, and it will be much more difficult to do well on the exams.

Homework will generally be posted on Wednesday mornings and due the following Friday (9 days later) by 12PM. Homework will be submitted via the course website and is required to be typed in LaTeX.

Additional Information

Academic Honesty: Cases of academic dishonesty can have very serious consequences. We will adhere to the university's academic honesty policy. For more information see: <https://aisc.uci.edu/students/academic-integrity/index.php>.

Accommodation Policies: If you need an accommodation to participate in this course, please email me no later than the end of the second week of class. Review the policies on accommodation at: <http://disability.uci.edu/>.

Resources for Remote Learning: The UCI Division of Teaching and Learning has set up a helpful website *Learn Anywhere*: <https://sites.uci.edu/learnanywhere>. This site has resources to help you get started with issues related to online courses. Please check out the UCI Remote Student Success Guide on that page.