

Math 3410 Course Outline

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Fall 2019

Summary

A second course in linear algebra. The Academic Calendar imposes the following topics:

Vector spaces over the real and complex numbers. Basis and dimension. Linear transformations. Change of basis. Gram-Schmidt orthogonalization. Eigenvectors and diagonalization. Canonical forms. Cayley-Hamilton Theorem.

Required prerequisite courses are Math 1410 (a first course in linear algebra), and Math 2000 (an introduction to proofs).

1 Welcome

Welcome to Math 3410 Linear Algebra, our most popular mathematics course at the 3000-level! Math 3410 is a second course in linear algebra. We will assume familiarity with basic computational procedures, like Gaussian elimination, matrix multiplication, etc.. We will take a dual-track approach in Math 3410, focusing on both theory and application. Theoretical content will demand some ability to write proofs. Applications will likely involve software and a small amount of coding.

Over the summer, the University of Lethbridge adopted an official recognition of our location on traditional Blackfoot territory. This acknowledgement also serves as a welcome message, and I am pleased to be able to include it here:

Oki, and welcome to the University of Lethbridge. Our University's Blackfoot name is Iniskim, meaning Sacred Buffalo Stone. The University of Lethbridge acknowledges and deeply appreciates the Siksikaitsitapii peoples' connection to their traditional territory. We, as people living and benefiting from Blackfoot Confederacy traditional territory, honour the traditions of people who have cared for this land since time immemorial. We recognize the diverse population of Aboriginal peoples who attend the University of Lethbridge and the contributions these Aboriginal peoples have made in shaping and strengthening the University community in the past, present, and in the future.

1.1 Course staff

My name is [Sean Fitzpatrick](#). You'll see me twice each week in class (right?), and I also handle most of the day-to-day organization. For any questions that you don't find answered in this outline,¹ you can email me at sean.fitzpatrick@uleth.ca, or drop by my office: C540 in University Hall.

1.2 Basic course information

Course website via [Moodle](#)

Course textbook *Linear Algebra With Applications*, by Keith Nicholson.

This is an OER textbook made available by [Lyryx Learning](#). The PDF will be available on Moodle.

Nicholson's book is one of several good open texts on linear algebra. I'll provide links to several others on Moodle. You are free to use any book you want; Nicholson's happens to cover the required content for Math 3410 better than others, so I'll be referring to it for scheduling purposes.

Class schedule We meet Tuesday and Thursday from 3:05 – 4:20 pm in SA6010.

Office hours Monday from 1 – 3 pm and Wednesday from 9 – 11 am.

If those times work you can email me for an appointment. Most weeks I can probably set aside an hour Wednesday afternoon, in case you don't want to compete with the 300 Math 1560 students I'm also teaching.

Grading Weighting of individual course components is given in [Table 2.2](#). Conversion to letter grades is given in [Table 2.3](#).

2 Frequently asked questions

2.1 Organizational questions

Questions related to the general operation of the course.

2.1.1 Can I get a print copy of the textbook?

The PDF is available on Moodle, and the open license for the book allows you to print it. I didn't set anything up for Print on Demand with the bookstore (partly because I didn't settle on a book soon enough). If you want to be able to order a print copy through the bookstore, let me know and I'll try to arrange something.

2.1.2 What does a typical lecture look like?

Generally we'll try to avoid a full 75 minutes of lecture, and leave time for hands-on work. (Trying proofs yourself is a lot more effective than watching me do them.) This means that you should *not* expect to see every bit of course content presented in detail during class. Do your best to come prepared.

Some classes we'll be covering material that can be computationally demanding. Rather than make you do it all by hand, I'll make software available. I'll let you know on Moodle which days will involve computer work. Bring a

¹Except questions about homework – there's a forum for that.

laptop if you can; if not, people can work together. Any computer capable of running a modern (non-mobile) web browser will do.

2.1.3 How do I find you if I need help with something?

My office is C540, in University Hall.

2.1.4 Do I need to make an appointment for office hours? What if I have class at that time?

You don't need an appointment -- just drop in. **Office hours** are the times that I promise to be available for consultation. If the times I choose don't work, you can email me for an appointment.

2.1.5 What if my question is not related to the course?

Come see me anyway, or send an email. If I can't help you myself, I'll try to direct you to someone who can. There's also some [great general advice for first year students](#) on the U of L website. You might be able to find an answer there.

2.1.6 OK, but what if it's kind of personal?

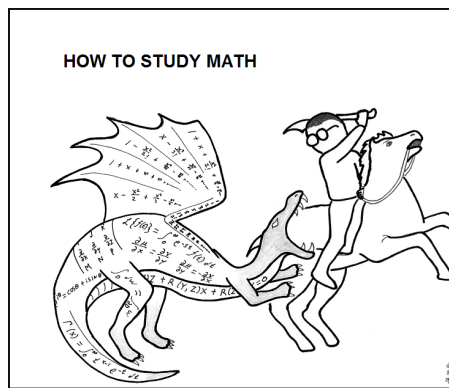
If it affects your ability to participate in the course (or even if it doesn't), you can come talk to me. In many cases, you might be best off seeing Academic Advising or Counselling Services. Links to these services, and general advice, can be found on the [U of L website](#).

You may also want to visit the University's [Health and Safety website](#) for information on other resources on campus.

2.1.7 How do I make sure I do well in this course?

That's a tricky question to answer in general, but here are some suggestions:

- Work ahead. The sooner you try things, the sooner you'll know what you need help with.
- Ask for help. Come to office hours whenever you can.
- Learn the definitions (all of them). But don't just memorize: make sure you understand what each one is saying. Come up with examples (on your own) that relate to them.
- Never, ever, say "I don't know where to begin!" on a problem, especially a proof. Assume the hypothesis. Write out the definitions (which you've learned) of any technical terms. You're probably already half-way there.
- Don't read your textbook like it's a novel. Reading math is a hands-on activity.



Don't just read it; fight it!
 — Paul R. Halmos

Figure 2.1 *Warrior*, from [Abstruse Goose](#).

—Paul Halmos

Don't just read it; fight it! Ask your own questions, look for your own examples, discover your own proofs. Is the hypothesis necessary? Is the converse true?... Where does the proof use the hypothesis?

2.2 Coursework and evaluation

2.2.1 What are your expectations of students?

- I expect you to make your best effort to arrive prepared for each class. I'm also aware that this is not always possible.
- I expect quality writing: complete sentences, proper use of notation, and clear exposition. I don't expect this right away, but I do expect you to work at improving.
- I expect you to treat your classmates with respect, and to contribute to group activities to the best of your ability.
- I expect you to ask for help when you need it. (Everyone does at some point.)

2.2.2 Thanks, but what I really meant is, how do I earn my grade?

Oh, right. The most frequently asked question of all. There are several different evaluation components that contribute to your grade:

Table 2.2 Relative weights of graded activities for Math 3410

Component	Number	Total Weight
Quizzes	11	10
Assignments	8	30
Term tests	2	30
Final exam	1	30

2.2.3 What is involved with each of the graded components?

Here are brief descriptions of each one:

Quizzes We'll start each week with a short quiz (10 minutes or so). Questions will be conceptual, or check your knowledge of definitions, etc.. Significant computational work is unlikely.

Assignments Take-home assignments will contain a mix of theory and application. You will be asked to write proofs. You will also be asked to solve computational problems. Computations can be done with the aid of a computer.

The preferred format for solutions to applied problems is the **Jupyter notebook**. All U of L students have access to the PIMS Jupyter hub, called **Syzygy**. Jupyter notebooks will allow you to write both text and Python code. I'll provide sample code to get you started. You don't need to be a programmer. (I'm not.) You just need to learn a few commands to perform things like matrix operations.

Tests There will be two term tests. **Test 1** is scheduled for Thursday, October 10th. **Test 2** is scheduled for Thursday, November 7th.

Note: Thursday, November 7th is just before the Fall Break. This is preferable for me, since it gives me time to grade your second test. But it's possible all your other instructors had the same idea. If that's the case, we can hold Test 2 on Tuesday the 19th instead.

Final Exam A traditional, cumulative, three-hour exam. Note that final exams are no longer scheduled according to the timetable, so the date of the final exam will not be known until sometime in October. You should plan to remain on campus for the entire exam period. The Registrar's Office *will not* allow you to reschedule due to travel conflicts.

2.2.4 How are letter grades calculated?

Each of the grade components above will be assigned a numerical score. These will be added to get a score out of 100 using [Table 2.2](#). Your score out of 100 is converted into a letter grade according to the following table.

Table 2.3 Conversion of percentage scores to letter grades in Math 3410

A+	A	A-	B+	B	B-	C+	C	C-	D+	D	F
95-100	90-94	86-89	82-85	77-81	73-76	69-72	64-68	60-63	56-59	50-55	0-49

2.3 Course policies

This section deals with questions about accommodations, missed tests, and other exceptional (yet common) cases.

2.3.1 One of the tests conflicts with something else in my schedule. What are my options?

If you know in advance that you will not be able to attend a test due to an "approved absence", like varsity athletics, a conference, tea with the Queen, etc., send me an email. We will try to arrange an alternate sitting of the test. (Individual stage only.)

2.3.2 I missed a test! What do I do? Do I get a zero?

Contact me ASAP to make alternate arrangements. Make-up tests are possible, but only if you contact me in time. (Advance notice is preferred when possible.) If no arrangements can be made, we will meet to discuss adjustments to your grading scheme.

2.3.3 Do I need a doctor's note?

No. This wastes health care resources and your time. Just email me to say you were sick. However, if you miss more than one test due to illness, we'll need to meet to discuss how to adjust your grade.

2.3.4 What if my car breaks down?

Same thing, for this, or other circumstances beyond your control. Send me an email, and we'll sort something out. But if there's a snowstorm forecast for the night before, maybe don't plan a trip to Calgary.

2.3.5 I'm on one of the Pronghorns teams.

Good for you!

Oh, you probably have some scheduling issues. Your coach should be providing you with a letter. Plan to meet with me during office hours one day and we'll sort something out.

2.3.6 I receive learning accommodations. What arrangements can I make?

First, make sure that you have registered with the University's [Accommodated Learning Centre](#). If you have exam accommodations, you'll need to schedule your exams with them. No need to let me know: they'll contact me to request a copy of your exam.

If you require any in-class accommodations, or if there are any adjustments I can make to facilitate your learning, please do not hesitate to get in touch with me. All students deserve an equal opportunity to learn.

2.3.7 Do we get to have calculators for the tests?

Yes. Maybe even a computer, if I decide that I want to include computational problems, and I can guarantee that everyone has access to a computer. (You can safely assume that if a computer *is* allowed, someone will be watching you like a hawk to make sure you don't use it inappropriately.)

2.3.8 Life intervened and I can't keep up this week. What do I do?

Send me an email. Extensions are usually granted as long as they're granted ahead of time. Online homework extensions need to be in place before solutions become available. See me if you're having trouble, or take a look at the other resources mentioned in [Question 2.1.6](#).

2.3.9 I missed class. What do I do?

If it's a one-time thing, don't worry about it. Drop by during office hours if you need to catch up. If circumstances are conspiring to keep you from class on a regular basis, please meet with me to come up with a plan to get you through the course.

2.3.10 Is there anything else I need to know?

Students are expected to abide by the policies and regulations as laid out in the [Academic Calendar](#). This includes the University's policies on plagiarism and academic misconduct. In Math 3410, this more or less amounts to not copying on the tests, and not getting someone else (including a website) to do your homework for you.

2.3.11 I have a question that isn't answered here. How do I contact you?

Short answer: you can [send me an email](#). There are a few caveats, however:

- First, check the course page (and the announcements forum) on Moodle. Any information I need to communicate to the class will be posted on Moodle, or emailed to the class as an announcement via Moodle.
- Is the question about homework? Email is not a good medium for discussing math. Your best option is to ask me in person. If that doesn't work, we have a class discussion forum, on [Piazza.com](#). You'll be able to access the forum via Moodle.

2.3.12 I sent you an email. Why haven't you answered it yet?

Here's a short troubleshooting guide:

- Your email was not sent from a ULeth account and had no subject line: It went to my spam folder.
- Your email sent between 10 pm and 6 am: I'm asleep. I'll answer when I get to work in the morning.
- Your email sent during office hours: I'm busy helping the students who are here in person. Consider dropping by yourself.
- Your email asked for help on a specific homework problem: Direct your question to the online forum.
- Your email was about something already addressed in this FAQ, and I need time to come up with a polite reply.

3 Course topics

The following table provides a list of the topics we'll attempt to cover in Math 3410, along with the dates I think we'll get to them, and where they can be found in the textbook.

Table 3.1 Math 3410 topics schedule for Fall 2019

September 5	Introduction and review	5.1 – 5.4
September 10	Vector spaces	6.1
September 12	Subspaces	6.2
September 17	Span and independence	6.3
September 19	Basis and dimension	6.4
September 24	Applications	6.5 – 6.6
September 26	Linear transformations	7.1
October 1	Kernel and image	7.2
October 3	Inverses and isomorphisms	7.3
October 8	Applications	7.4 – 7.5
October 10	Test 1	6.1 – 7.3
October 15	Inner products	10.1
October 17	Orthogonality	5.3, 10.2
October 22	Complement and projection	8.1
October 24	Diagonalization	8.2, 10.3
October 29	QR decomposition	8.3, 8.4
October 31	Singular value decomposition	8.5, 8.6
November 5	Complex matrices	8.7
November 7	Test #2	10.1 – 10.3, 8.1 – 8.6
November 19	Change of basis	9.1
November 21	Similarity	9.2
November 27	Direct sums	9.3
November 29	Triangular matrices	11.1
December 4	Jordan form	11.2