Math 1B03 -- Linear Algebra I (Fall 2017)

This course is an introduction to linear algebra. We are interested in both a computational approach (e.g., computing solutions to a linear system of equations) and a theoretical approach (e.g., an understanding of the underlying idea of a vector space). The prerequisites for this course are one of Grade 12 Calculus and Vectors U, Grade 12 Geometry and Discrete U, or MATH 1F03.

News Homework Handouts Grading Scheme Schedule Policies

Course Information

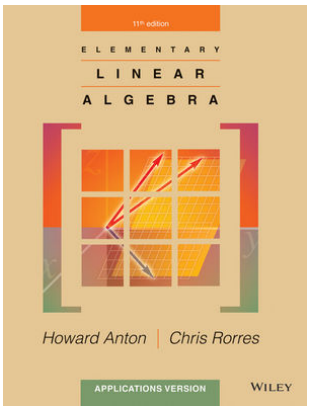
Instructor: Adam Van Tuyl

Office: Hamilton Hall 419
Office Hours: Monday 9:30-10:20, Wednesday 2:30-3:20
Email: vantuyl@math.mcmaster.ca

Place and Time:

Class C01: Monday, Wednesday 8:30-9:20 and Friday 10:30-11:20 in HSC (Health Science Centre) 1A1
Tutorial T01: Tu 1:30PM - 2:20PM in HH/302
Tutorial T02: Tu 12:30PM - 1:20PM in HH/302

TA: The TA for the course is **Homayun Karimi** (Tutorials start Tuesday, Sept 12, 2017)



Textbook:

- ***Elementary Linear Algebra: Applications Version 11th Edition***
  by Howard Anton, Chris Rorres
  Note that if you buy this book new at the bookstore, the bookstore will guarentee to buy it back for $90.00 (if you return it by Dec. 21, 2017).
- We will also use **Chapter 10** of the 9th Edition of this textbook on complex numbers.

News (Last Updated: Dec. 20, 2017)

FINAL EXAM Information

You can see your mark on the final exam on the homework portal. Your final mark will be available on MOSAIC.

You can access copies of lecture notes here:

- **Lectue notes from class**

Here is a summary of what we did in each class:

- **Dec. 20, 2017** Final marks have been submitted. Have a great break!
- **Dec. 15, 2017** Day of Final!
- **Dec. 4, 2017** We learned how to find the basis of the row and column spaces. We also learned about the rank-nullity theorem. Here's a **video**.
- **Dec. 1, 2017** Today we went back to Chapter 4 (Section 4.5) and talked about the dimension of a vector space. We also looked at the dimension of a null space of a matrix.
- **Nov. 29, 2017** We finished Section 6.3 by describing the Gram-Schmidt process. Here's a **video** on the process.
- **Nov. 27, 2017** We jumped to Section 6.3 to discuss the Gram-Schmidt process. Today we focused on orthogonal and orthonormal bases. Here's a **video**.
- **Nov. 24, 2017** I talked about Section 4.4 on how to determine the coordinates of a vector relative to a basis.
- **Nov. 22, 2017** We finished Section 4.3, and started our discussion on bases of vector spaces. Here's a helpful **video**.
- **Nov. 20, 2017** Today we started Section 4.3 on sets of linearly independent vectors.
- **Nov. 17, 2017** We finished our discussion on subspaces, and I introduced spanning sets.
- **Nov. 15, 2017** We discussed subspaces today (see Section 4.2). I also introduced the vector space of polynomials. Here's a video about **subspaces in R^2**.
- **Nov. 13, 2017** We started Chapter 4 on Vector Spaces. Make sure you carefully read Section 4.1, and know the examples of vector spaces.
- **Nov. 10, 2017** We continued our discussion of the geometry of linear algebra, and we went over the cross product. We talked about the geometric meaning of the determinant. Here's a **lecture** on the cross product.
- **Nov. 8, 2017** We looked at Section 3.3 and 3.4; we focused on the orthogonal project and the distance between planes and lines. Here's a **video** that gives a proof of the projection formula.
- **Nov. 6, 2017** We finished up Section 3.2 on the norm and dot product, and we started Section 3.3 on orthogonality. Here's a helpful **video**.
- **Nov. 3, 2017** Today we started Chapter 3. I introduced n-space

- **Nov. 1, 2017** We finished our last lecture on complex numbers. I spent today's class explaining the geometric implication (rotation) of complex eigenvalues.
- **Oct. 30, 2017** We had our second lecture on complex numbers. I explained some of the properties of the conjugate and the modulus. I also introduced the polar form of a complex number.
- **Oct. 27, 2017** In today's class, we started our introduction to complex numbers. You should know how to add, subtract, multiply, and divide complex numbers. As well, you should be able to find complex eigenvalues and eigenspaces involving complex numbers. Here's an **video introduction** to complex numbers.
- **Oct. 25, 2017** We finished our discussion on dynamical systems. You should know what a regular stochastic matrix is, and how to determine the limit of a regular Markov chain.
- **Oct. 23, 2017** We started Section 5.5 on dynamical systems.
- **Oct. 20, 2017** We finished up Section 5.2 on diagonalization. We learned about algebraic multiplicity and geometric multiplicity, and how to use this information to determine if a matrix is diagonalizable.
- **Oct. 18, 2017** Today we learned about diagonalizing a matrix (see Section 5.2 for more details). Here is a **video tutorial**.
- **Oct. 16, 2017** We finished Section 5.1; we discussed the characteristic equation and how to use this equation to find eigenvalues of a matrix, and how to find eigenvectors. Here is a **video**.
- **Oct. 6, 2017** We started Chapter 5 on eigenvalues and eigenvectors. I introduced these concepts with some simple examples (see Section 5.1). Note that the midterm marks will be posted by next week Tuesday. Have a good break!
- **Oct. 4, 2017** In class we went over some properties of the determinant. I also introduced the adjoint and Cramer's rule. See Section 2.3. Here's a **video** on Cramer's rule. The first midterm was today.
- **Oct. 2, 2017** We went over Section 2.2 which discussed how row operations change the determinant of a matrix. Here is a related **video**.
- **Sept. 29, 2017** We began our discussion of Chapter 2 by going over the definition of a determinant. Here are some videos that explain how to compute the determinant: **Video 1**, **Video 2**, and **Video 3**
- **Sept. 27, 2017** Today I introduced special types of matrices, like diagonal matrices, upper/lower triangular matrices, and symmetric matrices. For more, see Section 1.7. Note that the first midterm covers up to today's lecture.
- **Sept. 25, 2017** We focused on the remainder of Section 1.6. We discussed a classification of invertible matrices, and further properties of invertible matrices.
- **Sept. 22, 2017** We finished Section 1.5; in particular, we went over elementary matrices, and explained how they can be used to justify the inverse algorithm. We also started Section 1.6 to explain why inverse matrices are important when looking for system of

procedure to find the inverse of a matrix. Here is a **video** that also explains this procedure.

- **Sept. 18, 2017** We finished Section 1.4 on the algebraic properties of matrices.
- **Sept. 15, 2017** We went over the arithmetic properties of matrices. See Section 1.4 for more details.
- **Sept. 13, 2017** Today we went over operations involving matrices (e.g., addition, scalar multiplication, multiplying matrices). Here is a **video** on matrix multiplication.
- **Sept. 11, 2017** We finished our discussion of Gaussian elimination (Section 1.2). I focused on how to determine the number of solutions from the echelon form. I also introduced Matlab and explained how to do the homework. Here's another **video** on elimination that also uses Matlab.
- **Sept. 7, 2017** I introduced Gaussian elimination (see Section 1.2). It is important you learn this procedure. Here is an online **video** and another **video**.
- **Sept. 6, 2017** Today was the first day of classes. I handed out the course outline, and I went over the goals of the course. I also introduced system of linear equations (see Section 1.1).
- **August 31, 2017** Please note that there are no labs or tutorials during the first week of classes. We will meet next week Wednesday at 8:30 in class.
- **August 10, 2017** More information has been added to the webpage, including the course handout.
- **July 31, 2017** Today I started working on the webpage. Please check back as more information is added.

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Homework, Labs, and Practice Assignments

HOMEWORK:

There will be five assignments made available through online submission. They will be automatically graded if submitted before the deadline expires. You can access the assignments though this portal:

- Complete your assignments Online Submission System.

LABS:

There will be five labs which will require the use of Matlab (version 7 or later). These will be submitted using the online lab system. You can access the assignments though this portal:

- Complete your labs Online Submission System.

Here is the **Lab Schedule**. Specifically, this is a time and place that you can go to ask questions about Math 1B03 and Matlab.

You can access Matlab in the campus computer labs in BSB anytime in the opening hours (check opening hours), as long as there is not another class using them. There are scheduled lab times exclusive for MATH1B03. You do not have to attend any scheduled lab times. But TAs will be available if you need help at the times given on the Lab information page. Matlab can be purchased at the campus bookstore or online directly from **Mathworks**.

PRACTICE PROBLEMS:

In addition to the above assignments, it is suggested that you do the following practice problems. Answers are in the back of the book, and worked out solutions are in the student manual. It is suggested you first attempt the questions, and then check your answers.

Week 1 Practice

- Section 1.1: 5a, 7a, 11, 15, 17, 19, True-False Questions
- Section 1.2: 3,15, 17, 19, 23, True-False Questions

Week 2 Practice

- Section 1.3: 1, 5, 11a, 12a, 25, True-False Questions
- Section 1.4: 3, 5, 15, 21, 33, 39, True-False Questions

Week 3 Practice

- Section 1.5: 3, 5, 9, 13, 15, 19, True-False Questions
- Section 1.6: 5, 7, 15, 17, 21, True-False Questions

Week 4 Practice

- Section 1.7: 5, 13, 15a, 17, 27, True-False Questions
- Section 2.1: 9, 11, 13, 21, 23, 34, True-False Questions

Week 5 Practice

- Section 2.2: 1, 9 15, 23, 31, True-False Questions
- Section 2.3: 7, 9, 15, 19, 27, 33, True-False Questions
- Section 5.1: 3, 5, 7, 9, 13, 25, True-False Questions

Week 6 Practice

- Reading week -- no practice

Week 7 Practice

- Section 5.2: 3, 5, 7, 11, 13, 15, 19, 27, True-False Questions

Week 8 Practice

- Section 5.5: 1, 5, 7, 9, 11, 13, 15, 17, 19 True-False Questions
- Section 5.3: 1, 3, 5, 7, 9

Week 9 Practice

- Section 10.3: (9th ed.): 1, 3, 4
- Section 5.3: 15, 17, 19, 21, 23, 25, True-False Questions
- Section 3.1: 3, 7, 9, 11, 15, 19, 21, True-False Questions

Week 10 Practice

- Section 3.2: 1, 5, 9, 15, 17, True-False Questions
- Section 3.3: 1, 13, 15, 19, 29, True-False Questions
- Section 3.4: 17, 19, 25, True-False Questions (c,d,e,f)
- Section 3.5: 1, 7, 9, 13, True-False Questions

Week 11 Practice

- Section 4.1: 3,5, 9, 11, 13, 17, 21, True-False Questions
- Section 4.2: 1ace, 3ac, 7, 9, 11, 19, True-False Questions

Week 12 Practice

- Section 4.3: 1ab, 3a, 5, 9, 11, 15, 29, True-False Questions (not h)
- Section 4.4: 1, 3, 5, 7, 11, 13, 25, True-False Questions

Week 13 Practice

- Section 6.3: 1, 7, 9, 11, 13, 27, 29, 31
- Section 4.5: 1, 3, 9, 15, 17, True-False Questions
- Section 4.7: 3, 9, 11, 13a, 15, True-False Questions a,b,c,d,i,j
- Section 4.8: 3, 5, 7, True-False Questions a,c,e

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Handouts

All class handouts are available as PDF files.

Course Information
Course handout from first day of class

Midterm 1 Review Sheet
Handout describing first midterm.

Midterm 2 Review Sheet
Handout describing second midterm.

Final Exam Review Sheet
Handout describing final exam.

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Grading Scheme

10% = Labs (5 x 2%)
40% = Midterms (2 x 20%)
40% = Final Exam

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Schedule

We will be using the following schedule. Please note that there may be changes; always refer to the news section above for most recent information.

Week 1: September 4-8	
No Tutorials, Assignments, or Labs	
Lecture 1	Introduction 1.1 Systems of Linear Equations
Lecture 2	1.2 Gaussian Elimination I
Week 2: September 11-15	
ASSIGNMENT #1: Due at 11:59PM on Friday Sept. 15 NOTE: Matlab TA is **available this week**	
Lecture 3	1.2 Gaussian Elimination II
Lecture 4	1.3 Matrices and Matrix Operations
Lecture 5	1.3 Matrices and Matrix Operations (Continued) 1.4 Inverses, Properties of Matrices
Week 3: September 18-22	
LAB #1 (Matlab): Due at 11:59PM on Friday Sept. 22	
Lecture 6	1.4 Inverses, Properties of Matrices (Continued)
Lecture 7	1.5 Elementary Matrices

Lecture 8	1.5 Elementary Matrices (Contiued) 1.6 More Linear Systems and Invertible Matrices
Week 4: September 25-29	
ASSIGNMENT #2: Due at 11:59PM on Friday Sept. 29 NOTE: Matlab TA is **available this week**	
Lecture 9	1.6 More Linear Systems and Invertible Matrices (Continued)
Lecture 10	1.7 Diagonal, Triangular, and Symmetric Matrices
Lecture 11	2.1 Determinant by Cofactor Expansion
Week 5: October 2-6	
MIDTERM #1: Evening of Wednesday, October 4 LAB #2 (Matlab): Due at 11:59PM on Friday Oct. 6	
Lecture 12	2.2 Evaluating Determinants by Row Reduction
Lecture 13	2.3 Properties of Determinants (including Cramer's Rule)
Lecture 14	5.1 Eigenvalues and Eigenvectors
Week 6: October 9-13	
FALL BREAK - no classes	
Week 7: October 16-20	
ASSIGNMENT #3: Due at 11:59PM on Friday Oct. 20	
Lecture 15	5.1 Eigenvalues and Eigenvectors (Continued)
Lecture 16	5.2 Diagonalization

Lecture 17	5.2 Diagonalization (Continued)
Week 8: October 23-27	
LAB #3 (Matlab): Due at 11:59PM on Friday Oct. 27 NOTE: Matlab TA is **available this week**	
Lecture 18	5.5 Dynamical Systems
Lecture 19	5.5 Dynamical Systems (Continued)
Lecture 20	**10.1 (from 9th Edition)** Complex Numbers **10.2 (from 9th Edition)** Division of Complex Numbers
Week 9: October 30-November 3	
ASSIGNMENT #4: Due at 11:59PM on Friday Nov. 3	
Lecture 21	**10.2 (from 9th Edition)** Division of Complex Numbers **10.3 (from 9th Edition)** Polar Form of a Complex Number
Lecture 22	5.3 Complex Eigenvalues and Eigenvectors
Lecture 23	3.1 Vectors in 2-space, 3-space and n-space
Week 10: November 6-10	
MIDTERM #2: Evening of Wednesday Nov. 8	
Lecture 24	3.2 Norm, Dot product, and Distance in R^n
Lecture 25	3.3 Orthogonality 3.4 The Geometry of Linear Systems
Lecture 26	3.4 The Geometry of Linear Systems (Continued) 3.5 Cross Product

Week 11: November 113-17	
LAB #4 (Matlab): Due at 11:59PM on Friday Nov. 17 NOTE: Matlab TA is **available this week**	
Lecture 27	4.1 Real Vector Spaces
Lecture 28	4.1 Real Vector Spaces (Continued) 4.2 Subspaces
Lecture 29	4.2 Subspaces (Continued)
Week 12: November 20-24	
ASSIGNMENT #5: Due at 11:59PM on Friday Nov. 24	
Lecture 30	4.3 Linear Independence
Lecture 31	4.3 Linear Independence (Continued) 4.4 Coordinates and Basis
Lecture 32	4.4 Coordinates and Basis (Continued)
Week 13: November 27-December 1	
LAB #5 (Matlab): Due at 11:59PM on Friday Dec. 1 NOTE: Matlab TA is **available this week**	
Lecture 33	6.3 Gram-Schmidt Process
Lecture 34	6.3 Gram-Schmidt Process (Continued) 4.5 Dimension
Lecture 35	4.5 Dimension (Continued) 4.7 Row Space, Column Space, and Null Space
Week 14: December 4-6	

Lecture 37	Review

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Class Polices

1. Policy on Academic Ethics. You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: *Grade of F assigned for academic dishonesty*), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at: **http://www.mcmaster.ca/academicintegrity/**

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work,
- copying or using unauthorized aids in tests and examinations.

2. Policy regarding missed work. If you have missed work, it is your responsibility to take action. If you are absent from the university for medical and non-medical (personal) situations, lasting fewer than 3 days, you may report your absence, once per term, without documentation, using the McMaster Student Absence Form (MSAF). See **Requests for Relief for Missed Academic Term Work**

Absences for a longer duration or for other reasons must be reported to your Faculty/Program office, with documentation, and relief from term work may not necessarily be granted. ***In Math 1B03, the percentages of the missed work will be transferred to the final examination.*** Please note that the MSAF may not be used for term work worth 25% or more, nor can it be used for the final examination.

3. Student Accessibility Services. Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca. For further information, consult McMaster University's Policy for Academic Accommodation of Students

to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

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