McMaster University | SCIENCE
Department of Mathematics & Statistics

We recognize and acknowledge that McMaster University meets and learns on the traditional territories of the Mississauga and Haudenosaunee nations, and within the lands protected by the "Dish With One Spoon" wampum, an agreement amongst all allied Nations to peaceably share and care for the resources around the Great Lakes.

MATH 1B03 – LINEAR ALGEBRA I
2020 Fall Term

Home page: https://ms.mcmaster.ca/~vantuyl/courses/2020_fall_math1B03.html

For all updates, we will be using Avenue-To-Learn. Also on Avenue-to-Learn you will find the links to the virtual classes/tutorials, links to the prerecorded lectures, and links to the lecture notes.

SECTION 1 (CO1):

Time: Monday, Wednesday 2:30 - 3:20 PM and Friday 4:30 – 5:20 PM | **Location**: Virtual Classroom via WebEx

Instructor: Will Rushworth | **E-mail:** will.rushworth@math.mcmaster.ca

Office: Hamilton Hall 319 | **Office Hours:** (see https://ms.mcmaster.ca/~rushworw/)

SECTION 2 (CO2):

Time: Tuesday, Wednesday, Friday 12:30 - 1:20 PM | **Location**: Virtual Classroom via WebEx

Instructor: Adam Van Tuyl* | **E-mail:** vantuyl@math.mcmaster.ca | **Phone Extension:** x27016

Office: Hamilton Hall 419 | **Office Hours:** (see https://ms.mcmaster.ca/~vantuyl/)

* Dr. Adam Van Tuyl is the course coordinator.

NOTE: Both sections will be following the same schedule. The assignments, labs, and the final will also be the same.

COURSE DESCRIPTION
From the academic calendar (2020-21):

> Vector spaces given by solutions to linear systems. Linear independence, dimension. Determinants. Eigenvalues, eigenvectors and diagonalisation. Complex numbers.
>
> Three lectures, one tutorial; one term
>
> *Prerequisite(s):* Grade 12 Calculus and Vectors U or MATH 1F03

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). For the 2020-21 academic year, the course material will primarily be presented through prerecorded lectures. Class and tutorial times will primarily be devoted to problem solving and quizzes. There will be weekly homework, computer labs, and quizzes. The final exam will be cumulative.

COURSE AND LEARNING OBJECTIVES

Course Objectives:

MATH 1B03 is the first course on linear algebra. By the end of this course, students should be able to:

- *do computations involving matrices*. For example, you should be able to solve systems of linear equations using Gauss-Jordan elimination, to be comfortable with matrix arithmetic, to compute determinants, and to find eigenvalues/eigenvectors of a matrix. Labs and assignments will facilitate this objective.

- *explain some theoretical underpinnings of linear algebra*. For example, you should be able to understand the language of vector spaces to develop a theory that supports and describes what is observed in the computations above. As well, you will practice critical thinking skills by demonstrating understanding of the concepts encountered in both computational and theoretical contexts. Labs and assignments will facilitate this objective.

MATERIALS & FEES

REQUIRED MATERIALS/ RESOURCES

Textbook Information:

- **(Required)** We will be using *Linear Algebra and its Applications (6th Edition)* by D. Lay, S. Lay, and J. McDonald. You can purchase or rent a PDF version of this textbook. If you want a hard copy, you need to purchase access to the publishers MyLab, and then purchase the loose-leaf version through their website. If you do purchase the version with MyLab, you need the course id number which is:
  course id: **vantuyl21474**
  We will not be using MyLab, so it is not required that you have access to this feature.

- **(Alternative)** You can also use the 5th Edition of this book. Please note that this book is used in the follow up course Math 2LA3. The 5th edition is missing a chapter used in Math 2LA3, so if you plan on taking this course, the 6th edition is recommended.

- **(Optional)** Student Solutions Manual for Elementary Linear Algebra - Applications Version.

VIRTUAL COURSE DELIVERY

To follow and participate in virtual classes it is expected that you have reliable access to the following:

- A computer that meets performance requirements found here.
- An internet connection that is fast enough to stream video.
- Computer accessories that enable class participation, such as a microphone, speakers and webcam when needed.

If you think that you will not be able to meet these requirements, please contact uts@mcmaster.ca as soon as you can. Please visit the Technology Resources for Students page for detailed requirements. If you use assistive technology or believe that our platforms

might be a barrier to participating, please contact Student Accessibility Services, sas@mcmaster.ca, for support.

COURSE OVERVIEW AND ASSESSMENT

Topics:

We will cover the following topics: vector spaces given by solutions to linear systems; linear independence; dimension; determinants; eigenvalues and eigenvectors; diagonalisation; and complex numbers.

Course Delivery:

The course will be delivered using both asynchronous and synchronous components. The asynchronous component consists of video lectures of the course material (posted on Avenue and YouTube). For the synchronous component, we will use the scheduled class time as follows:

- *First lecture of the week*. (Monday or Tuesday depending on section) The scheduled class time will be used as a problem solving session based upon the online lectures of the previous week.

- *Second lecture of the week*. (Wednesday for both sections) There will be an online 20 minute quiz based upon the lectures of the previous week. The quizzes between the two sections will be different, but have the same level of difficulty. The remainder of the scheduled class time can be used to catch up on videos and/or ask your instructors questions. They will be online during this time.

- *Third lecture of the week*. (Friday for both sections) Instructors will be online to answer questions, but the time can be used by you to watch the video lectures.

MATH 1B03 (Provisional) Calendar – Fall 2020

We will be using the following schedule. Please note that there may be changes; always refer to Avenue-to-Learn for the latest information.

Week	Lecture Topics		Key Deadlines & Notes
1 - (Sept 8-11)	Lecture 1	Introduction 1.1 Systems of Linear Equations	No Tutorials, Assignments or Labs NOTE: The first lecture for Sections C01 and C02 is on September 9
	Lecture 2	1.2 Row Reduction and Echelon Forms	
2 - (Sept 14-18)	Lecture 3	1.2 Row Reduction and Echelon Forms (Continued) Introduction to Octave	**QUIZ #1**: Wednesday during class time **ASSIGNMENT #1**: Due at 11:59pm on September 20
	Lecture 4	1.3 Vector Equations	
	Lecture 5	1.4 Matrix Equation Ax = b	
3 - (Sept 21-25)	Lecture 6	1.5 Solution Sets of Linear Equations	**QUIZ #2**: Wednesday during class time **LAB #1**: Due at 11:59pm on September 27
	Lecture 7	1.7 Linear Independence	
	Lecture	1.8 Introduction to Linear	

	8	Transformations	
4 - (Sept 28-Oct 2)	Lecture 9	1.9 Matrix of a Linear Transformation	**QUIZ #3**: Wednesday during class time
	Lecture 10	1.6 Applications of Linear Systems	**ASSIGNMENT #2**: Due at 11:59 on October 4
	Lecture 11	2.1 Matrix Operations	
5 - (Oct 5-9)	Lecture 12	2.2 The Inverse of a Matrix	**QUIZ #4:** Wednesday during class time
	Lecture 13	2.2 The Inverse of a Matrix (continued) 2.3 Characterizations of Invertible Matrices	**LAB #2:** Due at 11:59pm on October 11
	Lecture 14	2.3 Characterizations of Invertible Matrices (continued) 2.4 Partitioned Matrices	
6 - (Oct 12-18)	Midterm Recess – no classes		
7 - (Oct 19-23)	Lecture 15	2.7 Applications to Computer Graphics	**QUIZ #5**: Wednesday during class time
	Lecture 16	3.1 Introduction of Determinants	**ASSIGNMENT #3**: Due at 11:59pm on October 25
	Lecture 17	3.2 Properties of Determinants	
8 - (Oct 26-30)	Lecture 18	3.3 Cramer's Rule, Volume, and Linear Transformations	**QUIZ #6:** Wednesday during class time
	Lecture 19	4.1 Vector Spaces and Subspaces	**LAB #3:** Due at 11:59pm on November 1
	Lecture 20	4.1 Vector Spaces and Subspaces (continued) 4.2 Null Spaces, Column Spaces, and Linear Transformations	
9 - (Nov 2-6)	Lecture 21	4.2 Null Spaces, Column Spaces, and Linear Transformations (continued)	**QUIZ #7:** Wednesday during class time
	Lecture 22	4.3 Linear Independent Sets and Bases	**ASSIGNMENT #4**: Due at 11:59 pm on November 8
	Lecture 23	4.4 Coordinate Systems	
10 - (Nov 9-13)	Lecture 24	6.1 Inner Product, Length, and Orthogonality 6.2 Orthogonal Sets	**QUIZ #8:** Wednesday during class time
	Lecture 25	6.3 Orthogonal Projections 6.4 Gram-Schmidt Process	**LAB #4**: Due at 11:59pm on November 15
	Lecture 26	4.5 Dimension of a Vector Space	
11 - (Nov 16-20)	Lecture 27	4.5 Dimension of a Vector Space (continued) (Section 4.6 in 5th Edition)	**QUIZ #9:** Wednesday during class time
	Lecture 28	5.1 Eigenvectors and Eigenvalues	**ASSIGNMENT #5**: Due at 11:59pm on November 22
	Lecture	5.2 The Characteristic Equation	

		29		
12 - (Nov 23-27)	Lecture 30	5.3 Diagonalization	**QUIZ #10:** Wednesday during class time	
	Lecture 31	5.3 Diagonalization (Continued)	**LAB #5:** Due at 11:59pm on November 29	
	Lecture 32	5.4 Eigenvectors and Linear Transformations		
13 - (Nov 30-Dec 4)	Lecture 33	Appendix B Introduction to Complex Numbers	**QUIZ #11**: Wednesday during class time	
	Lecture 34	5.5 Complex Eigenvalues	No lab or assignment this week	
	Lecture 35	5.6 Discrete Dynamical Systems		
14 - (Dec 7-9)	Lecture 36	5.9 Applications to Markov Chains (Section 4.9 in 5th Edition)	**ASSIGNMENT #6:** Due at 11:59pm on December 9 (NOTE DATE!)	
	Lecture 37	Review		

EVALUATION

Assignment Information:
There will be six assignments made available through online submission. They will be automatically graded if submitted before the deadline expires. A link to the assignments will be on the class web page and Avenue-to-Learn. Each assignment will consist of multiple-choice questions. See the calendar above for due dates.

Lab Information:
There will be five labs which will require the use of Matlab (version 7 or later) or Octave Online (https://octave-online.net/). The syntax of Octave is very similar to that of Matlab. These will be submitted using the same online system as the homework assignments. Matlab can be purchased at the campus bookstore or online directly from Mathworks (https://www.mathworks.com/store/). However, if you wish, everything can be done via Octave Online, which is free. See the calendar above for due dates.

Quizzes:
There will be weekly quizzes for a total of 11 quizzes. Your quiz mark will be based upon your best 8 quizzes. You will be required to write out solutions for your quiz. Quizzes will be done via Childsmath. Quizzes will be done during your scheduled class time (you must write with your own section).

Final Exam Information:
The final examination (duration 2.5 hours) will be scheduled by the registrar. The registrar will publish more information on the exams at a later date. The exam will cover all the material from the course; details on topics covered will be announced on Avenue. **At this time, we are still working out the details of the final exam**.

Marking Scheme Information.
Your final mark will be calculated in two ways:

Weight 1

Assessment	Weight
1. Final Examination	38%
2. Quizzes	Best 8 at 5% each = 40%
3. Labs and Assignments	11 at 2% each = 22%

Weight 2

Assessment	Weight
1. Final Examination	58%
2. Quizzes	Best 8 at 2.5% each = 20%
3. Labs and Assignments	11 at 2% each = 22%

Your final mark will the highest of the above two numbers.

Course Support:

In order to help you succeed in this course, the following services are available to you.

- **Practice Problems**. Suggested problems and practice tests/exams will be made available on the class webpage/Avenue.
- **Tutorials**. There is a one hour tutorial each week. The tutorials are intended to provide additional material to help students learn the course material, and provide opportunities to ask additional questions and seek help. Although attendance in tutorials is not mandatory, it is strongly encouraged. There are two tutorial sections:
  - o T01: We 10:30AM - 11:20AM (online)
  - o T03: We 10:30AM – 11:20AM (online)
  - o T02: Tu 11:30AM - 12:20PM (online)
  - o T04: Tu 11:30AM – 12:20PM (online)
- **Drop-In Centre.** More personalized assistance can be obtained by coming to the Math Drop-In Centre on the first floor of Hamilton Hall. It is expected that an online form of the Drop-In Centre will be available in 2020-21. Tutors are freely available to assist with linear algebra questions. More detailed times and information is available on their web site: https://www.math.mcmaster.ca/undergraduate/math-drop-in-centre.html

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

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).

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.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COURSES WITH AN ON-LINE ELEMENT

In this course we will be using YouTube, WebEx, Avenue-To-Learn, and Childsmath (https://www.childsmath.ca/childsa/forms/main login.php), a local website hosted by the department. Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure.   If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software

during tests or exams. This software may be required to be installed before the test/exam begins.

ACADEMIC INTEGRITY

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.

It is your responsibility to understand what constitutes academic dishonesty.

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. For information on the various types of academic dishonesty please refer to the *Academic Integrity Policy,* located at https://secretariat.mcmaster.ca/university-policies-procedures- guidelines/

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.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all our living, learning and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be

investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

RESEARCH ETHICS – NA

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.