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
2022 Fall Term

COURSE DATES: September 6 – December 8, 2022

Updated November 20, 2022

The course will be team taught by Drs Franc, Marboeuf, Moon and Zhao.

Please check Mosaic before the start of class for the latest information. We will give more definite information on exams and assignments closer to the dates of these assessments.

This course will run fullyin-person in accordance with university directives and strict health and safety guidelines. It is the expectation that students be prepared to attend all lectures, labs/tutorials, tests, exams, and other evaluations in-person. However, students must be prepared to move to virtual learning should there be a change to health regulations and restrictions as issued by the Province or University.

SECTION 1 (CO1):
Time: MWTh, 10:30-11:20.
Location: JHE 376

Instructor: Cameron Franc* | **E-mail:** franc@math.mcmaster.ca
Office: Hamilton Hall 310 | **Office Hours:** 10:30am-11:30am on Thursdays

* Dr. Franc is the course coordinator.

SECTION 2 (CO2):

Time: MWTh, 1:30-2:20
Location: JHE 376

Instructor: Xinyu Zhao | **E-mail:** zhaox171@mcmaster.ca
Office: Hamilton Hall 403 | **Office Hours:** 2:30pm-3:30pm on Wednesdays

SECTION 3 (CO3):
Time: MWTh, 4:30-5:20
Location: JHE 376

Instructor: Alexis Marboeuf | **E-mail:** marboeua@mcmaster.ca
Office: Hamilton Hall 409| **Office Hours:** 3:00pm-4:00pm on Mondays

Time: Times communicated by email)
Location: Zoom (online)

Instructor: Sungju Moon | **E-mail:**   moons18@mcmaster.ca
Office: Hamilton Hall | **Office Hours:** Online 30 minutes after class Monday, Thursday.

Teaching Assistants:
John Nicholson | **E-mail:** nichoj6@mcmaster.ca | **Office Hours:** TBA
Madison Goertz | **E-mail:** goertzm@mcmaster.ca | **Office Hours:** TBA

NOTE: All sections will follow the same schedule. The assignments, tests, and the final exams will also be the same.

Course Description

- From the academic calendar (2022-23):

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

Antirequisite(s): MATH 1ZC3

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 Fall 2022 academic term, the course will be team taught across three sections, with Dr. Franc coordinating. There will be weekly homework through Childsmath (except for the weeks of the midterms), three computer assignments, two midterm exams, and a final exam. A detailed grade breakdown is provided below. Exams are 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. Homework and labs 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. Homework and labs 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. We will not be using the associated MyLab material, and so you don't need to purchase it.
- **(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.

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 three sections of MATH 1B03 will be taught in a coordinated manner with common exams and assignments. Students will attend three lecture hours per week. Additionally, there will be a number of tutorial sections. Students are strongly encouraged to attend their assigned tutorials. Tutorials will supplement lectures with additional problem solving, assistance with computer usage, and homework support. Additional support material, including video lectures from previous semesters, will be posted to the Avenue to Learn course webpage. Please check Avenue to Learn and your school email account frequently for course updates.

MATH 1B03 (Provisional) Calendar – Fall 2022

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
1 - (Sept 6-9)	Lecture 1	Introduction 1.1 Systems of Linear Equations	
	Lecture 2	1.2 Row Reduction and Echelon Forms	
2 - (Sept 12-16)	Lecture 3	1.2 Row Reduction and Echelon Forms (Continued) Introduction to Octave	
	Lecture 4	1.3 Vector Equations	
	Lecture 5	1.4 Matrix Equation Ax = b	**ASSIGNMENT #1: Due at 5:00pm on Thursday September 15**
3 - (Sept 19-23)	Lecture 6	1.5 Solution Sets of Linear Equations	
	Lecture 7	1.7 Linear Independence	
	Lecture 8	1.8 Introduction to Linear Transformations	**ASSIGNMENT #2: Due at 5:00pm on Thursday September 22**
4 - (Sept 26-30)	Lecture 9	1.9 Matrix of a Linear Transformation	**COMPUTER ASSIGNMENT #1: Due at 5:00pm on Monday September 26**
	Lecture 10	1.6 Applications of Linear Systems	
	Lecture 11	2.1 Matrix Operations	**ASSIGNMENT #3: Due at 5:00pm on Thursday September 29**
5 - (Oct 3-7)	Lecture 12	2.2 The Inverse of a Matrix	
	Lecture 13	2.2 The Inverse of a Matrix (continued) 2.3 Characterizations of Invertible Matrices	
	Lecture 14	2.3 Characterizations of Invertible Matrices (continued) 2.4 Partitioned Matrices	**MIDTERM #1: Wednesday October 5, 7-8pm**
6 - (Oct 10-16)		Midterm Recess – no classes	
7 - (Oct 17-21)	Lecture 15	2.7 Applications to Computer Graphics	
	Lecture 16	3.1 Introduction of Determinants	
	Lecture 17	3.2 Properties of Determinants	**ASSIGNMENT #4: Due at 5:00pm on Thursday October 20**
8 - (Oct 24-28)	Lecture 18	3.3 Cramer's Rule, Volume, and Linear Transformations	
	Lecture 19	4.1 Vector Spaces and Subspaces	
	Lecture 20	4.1 Vector Spaces and Subspaces (continued) 4.2 Null Spaces, Column Spaces, and Linear Transformations	**ASSIGNMENT #5: Due at 5:00pm on Thursday October 27**
9 – (Oct 31-Nov4)	Lecture 21	4.2 Null Spaces, Column Spaces, and Linear Transformations (continued)	**COMPUTER ASSIGNMENT #2: Due at 5:00pm on Monday October 31**
	Lecture 22	4.3 Linear Independent Sets and Bases	
	Lecture 23	4.4 Coordinate Systems	**ASSIGNMENT #6: Due at 5:00pm on Thursday November 3**
10 - (Nov 7-11)	Lecture 24	6.1 Inner Product, Length, and Orthogonality 6.2 Orthogonal Sets	

	Lecture 25	6.3 Orthogonal Projections 6.4 Gram-Schmidt Process	**ASSIGNMENT #7: Due at 5:00pm on Thursday November 10**
	Lecture 26	4.5 Dimension of a Vector Space	
11 - (Nov 14-18)	Lecture 27	4.5 Dimension of a Vector Space (continued) (Section 4.6 in 5th Edition)	**MIDTERM #2: Monday November 14, 7-8pm**
	Lecture 28	5.1 Eigenvectors and Eigenvalues	
	Lecture 29	5.2 The Characteristic Equation	
12 - (Nov 21-25)	Lecture 30	5.3 Diagonalization	
	Lecture 31	5.3 Diagonalization (Continued)	
	Lecture 32	5.4 Eigenvectors and Linear Transformations	**ASSIGNMENT #8: Due at 5:00pm on Thursday November 24**
13 - (Nov 28-Dec 2)	Lecture 33	Appendix B Introduction to Complex Numbers	~~COMPUTER ASSIGNMENT #3: Previously due on Monday November 28~~ (CANCELLED)
	Lecture 34	5.5 Complex Eigenvalues	
	Lecture 35	5.6 Discrete Dynamical Systems	
14 - (Dec 5-8)	Lecture 36	5.9 Applications to Markov Chains (Section 4.9 in 5th Edition)	**ASSIGNMENT #9: Due at 5:00pm on Thursday December 8**
	Lecture 37	Review	

Evaluation

Assignment Information:

There will be nine assignments made available via online submission to Childsmath. A link and information will be posted on Avenue to Learn and discussed in class. These weekly assignments are intended to be a low-stakes means for us to assess student learning. See the calendar above for due dates, which will also be posted to Avenue to Learn.

Computer Assignment Information:

There will be TWO computer assignments throughout the semester. These assignments will be slightly longer than the weekly assignments and are designed to introduce students to the use of computers in linear algebraic computations. More details will be posted throughout the semester. Students will have the option of completing the assignments using MATLAB or Octave. Teaching assistants will provide support for these computer assignments during the scheduled tutorials.

Midterm Test Information:

There will be two 1 hour in-person midterm exams. Content coverage and other exam information will be posted to Avenue to Learn closer to the exam dates. Tentative dates are listed in the schedule above, but they have not been confirmed yet and may change.

Final Exam Information:

The final examination will consist of a 2 hour exam 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 to Learn.

Marking Scheme Information.

Your final mark will be calculated as follows:

Assessment	Weight	Notes
1. Final Examination	43%	Scheduled by registrar
2. Midterm 1	13%	October 5, 7-8pm
2. Midterm 2	13%	November 14, 7-8pm
3. Assignments	21%	Best 7 of 9 at 3% each
4. Computer assignments	10%	Best 1 of 2

If an MSAF is applied to an assignment, then we will use the best 7 of the remaining 8 assignments for the final grade computation. Likewise, if an MSAF is applied to a computer assignment, the remaining computer assignment grade will be used for the final grade computation. If an MSAF is used for a midterm exam, that portion of the grade will be shifted to the final exam, so that the final exam will be worth 56% of your final grade in that circumstance.

Course Support:

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

- **Practice Problems.** Suggested homework problems and practice tests/exams will be made available on Avenue to Learn.
- **Tutorials.** There are six one hour tutorials each week, and you are encouraged to attend your scheduled tutorials. 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. Tutorial information to be announced.
- **Drop-In Centre.** More personalized assistance can be obtained by coming to the Math Drop-In Centre on the first floor of Hamilton Hall. 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, which includes the Midterm Test, 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, Microsoft Teams, MyMathlab and possibley Crowdmark 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 the [McMaster Office of Academic Integrity's](#) webpage.

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.