Department of Mathematics & Statistics
Concordia University

MAST 234: Linear Algebra & Applications I (Fall 2026)

Instructor:	Dr. Ben Hersey
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Office Hours:	_____
Important:	Students should get the above information from their instructor and from the course Moodle site. The instructor is the person to contact should there be any questions about the course.
Class Schedule:	Tuesdays & Thursdays, 11:45-13:00.
Prerequisites:	MATH 204 or equivalent.

Reading Week

Begins on Saturday, October 10 and ends on Friday, October 16, 2026. No classes that week.

Text

There is no mandatory textbook for this course, all the material will be available in the Lecture files and the Classwork files that will be posted on the course page on Moodle. For additional reading and practice at home, most of the topics covered in this course can be found in the following complementary open-source text:

(A) *Linear Algebra with Applications*, by W. Keith Nicholson, Open Texts by Lyryx
https://lyryx.com/wp-content/uploads/2018/01/Nicholson-OpenLAWA-2018A.pdf

Objectives

There are two major concepts, *General Vector Spaces* and *Linear Transformations,* on which this course is based. In learning these concepts we will use related constructs such as *vectors*, *matrices,* and *systems of linear equations*. The objective of the course is to master your understanding and skills in these key concepts of Linear Algebra that will be critical for further Linear Algebra courses in your curriculum.

Software

All coursework will be carried out using *SageMath*, using *JupyterLab* as an IDE. Both *SageMath* and *JupyterLab* are free, open source, software systems. If you would like to install these programs on

your personal computer, you can visit https://www.sagemath.org/ and https://jupyter.org/, or ask your instructor for help. In this course the software is only used as a computational tool, ***not* as an object of study** in itself. All assignments, quizzes, the midterm test and the final examination will be completed using SageMath.

Quizzes

At the beginning of *most* classes, there will be a short (< 5min) quiz. They will typically review your knowledge of the definitions and theorem statements that will be needed in the following lecture. They will be self corrected, submitted, and marked based on completion (with a reasonable attempt). You will gain 1% toward your total quiz grade for each 3 quizzes you complete (a total of 15 required to get the full 5%).

Assignments

Assignments (homework) are assigned and submitted online through Moodle. Late assignments **will not** be accepted. Assignments contribute 10% to your final grade (see the grading schemes below). *W*orking regularly on the assignments is essential for success in this course.

Midterm Test

There will be **one midterm test**, written in class, during week 6 or 7. The exact date of the midterm, as well as the topics covered, will be announced at least two weeks in advance of the test. The midterm test must be completed using a computer in the computer lab. It will contribute up to 30% toward your final grade (see the Grading Scheme below).

NOTE: Tests that are missed for any reason, **including illness,** cannot be made up. If you miss the midterm for any reason, the final exam will count for 85% of your final grade (see the Grading Scheme below).

Final Exam

The Final Examination will be 3 hours long (**closed-book** exam, no notes or electronic material is allowed) written using SageMath and on one of the computers in the computer lab.

PLEASE NOTE: Students are responsible for finding out the date and time of the final exam once the schedule is posted by the Examination Office. Any conflicts or problems with the scheduling of the final exam must be reported directly to the Examination Office, **not** to your instructor. It is the Department's policy and the Examination Office's policy **that students are to be available until the end of the final exam period. Conflicts due to travel plans will not be accommodated.**

NOTE: There are **no supplemental exams** for this course.

Grading Scheme

The final grade will be based on the higher of (a) and (b) below:

(a) 5% for quizzes
10% for assignments
30% for the class test
55% for the final examination

(b) 5% for quizzes
10% for assignments
85% for the final examination

If the grading scheme for this course includes graded assignments, a reasonable and representative subset of each assignment may be graded. Students will not be told in advance which subset of the assigned problems will be marked and should therefore attempt all assigned problems.

Disclaimer

The instructor reserves the right to make changes to the course outline and course content should this be necessary for academic or other reasons.

CONTENTS

Week	Lectures TOPICS	Sub-Topics considered	Complementary Reading (KN Text)
1	Linear Systems Row Equivalent Matrices & GJ Method for LS	• Review of systems of linear equations. ○ Matrix form of a system ○ Matrix of the system; augmented matrix ○ Elementary Row Operations ○ Row Echelon Form ○ GJ Solutions for a system of linear equations	**Sections** **KN: 1.1, 1.2**
2	Span of Vectors Matrices Consistent systems RANK	• Review of vectors and matrices ○ Vectors in R^n. Linear combination of vectors ○ Matrix Operations, Matrix-vector products • Span of a set of vectors • Matrix Rank, Column & Row Spaces • Rank Theorems, Consistency of systems Ax=b	**Sections** **KN: 1.2, 2.1, 2.2, 2.3**
3	Homogeneous Systems Linear Dependence	• Linear dependence of vectors/vector sets • Homogeneous Systems of Equations • Null Space of a matrix	**Sections** **KN: 1.3, 5.2, 5.4**
4	Operations on Matrices Determinants	• Operations on matrices ○ Multiplication of matrices: definition and properties ○ Special matrices • Determinants (an introductory overview)	**Sections** **KN: 2.3, 2.4, 3.1, 3.2, 5.4**
5	Matrix Inverse	• Left and Right inverses of Matrices. • Invertible matrix (square) • Properties of invertible matrices.	**Sections** **KN: 2.4, 3.2**
6	Linear Transformations in R^n	• Linear transformations in R^n ○ Domain, Co-domain, Range: ○ The Linearity properties: definition and examples ○ Matrices and linear maps: Theorems 1-3. ○ Composition of linear mappings (Theorem 2.3.8)	**Sections** **KN: 2.2, 2.3, 2.6**
7	General Vector Spaces and Subspaces	• Examples of Vector Spaces R^n & Euclidean vector spaces Polynomials as vectors • Definition of Vector spaces, and its Properties • Linear Independence in Vector spaces. • Vector Subspaces	**Sections** **KN: 6.1,6.2, 6.3**

8	Basis, Coordinatization Transition Matrices	• Basis for a vector space & Dimension Theorems on Spans and Basis • Coordinate vector, Coordinatization • Coordinates in different basis • Transition matrices from one basis to another.	**Sections KN: 6.3, 6.4**
9	Linear Transformations for General Vector Spaces	• Linear transformations in abstract vector spaces, other than R^n • Rank-Nullity Theorem • Matrix representation of a linear transformation • Matrices of linear mappings of a vectors space into itself ○ Similar matrices	**Sections KN: 9.1, 9.2, 5.5**
10	Complex Numbers	• Definition of the complex numbers • Arithmetic of Complex numbers • The Fundamental Theorem of Algebra	**Sections: KN: Appendix A**

11	Eigenvalues and Eigenvectors of a Matrix	• Eigentheory Basics
		  ○ Eigenvectors and eigenvalues of matrices
		  ○ Characteristic polynomial
		  ○ Eigenvectors and eigenvalues of a linear operator
			Sections KN: 3.3, 5.5. 9.3

12	Diagonalizable Matrices	• Diagonalizable matrices and diagonalizable linear operators
		  ○ Conditions of diagonalizability: basis of eigenvectors.
		  ○ Numerical methods for diagonalizatio
		• Application of diagonalization (Dynamical systems)
			Sections KN: 5.5, 9.2

Student Services

You may wish to access the many services available to you as a Concordia student. An overview of these resources can be found here: https://www.concordia.ca/students/services.html

Academic Integrity and the Academic Code of Conduct

This course is governed by Concordia University's policies on Academic Integrity and the Academic Code of Conduct as set forth in the Undergraduate Calendar and the Graduate Calendar. Students are expected to familiarize themselves with these policies and conduct themselves accordingly. "Concordia University has several resources available to students to better understand and uphold academic integrity. Concordia's website on academic integrity can be found at the following address, which also includes links to each Faculty and the School of Graduate Studies: https://www.concordia.ca/conduct/academic-integrity.html" *[Undergraduate Calendar, Sec 17.10.2]*

Behaviour

All individuals participating in courses are expected to be professional and constructive throughout the course, including in their communications.

Concordia students are subject to the Code of Rights and Responsibilities which applies both when students are physically and virtually engaged in any University activity, including classes, seminars, meetings, etc. Students engaged in university activities must respect this Code when engaging with any members of the Concordia community, including faculty, staff, and students, whether such interactions are verbal or in writing, face to face or online/virtual. Failing to comply with the Code may result in charges and sanctions, as outlined in the Code.

Intellectual Property

Content belonging to instructors shared in online courses, including, but not limited to, online lectures, course notes, and video recordings of classes remain the intellectual property of the faculty member. It may not be distributed, published or broadcast, in whole or in part, without the express permission of the faculty member. Students are also forbidden to use their own means of recording any elements of an online class or lecture without express permission of the instructor. Any unauthorized sharing of course content may constitute a breach of the Academic Code of Conduct and/or the Code of Rights

and Responsibilities. As specified in the Policy on Intellectual Property, the University does not claim any ownership of or interest in any student IP. All university members retain copyright over their work.

Use of Concordia email

Your Concordia email is the official channel for all university communications, as required by the university's Policy on Concordia email accounts for students and employees. Please use your Concordia email for all communication related to this course and check it regularly so you don't miss important information. Learn more about how to access your Concordia email.

As a student, you are expected to follow the email policy and to use your Concordia email in a respectful and responsible manner. The policy helps ensure that communication across the university is secure, reliable, and consistent.

Extraordinary circumstances

In the event of extraordinary circumstances and pursuant to the Academic Regulations the University may modify the delivery, content, structure, forum, location and/or evaluation scheme. In the event of such extraordinary circumstances, students will be informed of the change.