

Elementary Linear Algebra
Spring 2024 CRN: 29142 Credit Hours: 3
Math 1890 Sec. 002 TR 9:35 - 10:55 AM Room: Memorial Field House 1200

Instructor: Dr. David Gajewski
Office: University Hall 3014
Office Hours: Tues 11-1, Wed 2-4, Thurs 12-1, Fri 12-1, and also by appointment.
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CATALOG DESCRIPTION

MATH1890 is a first course in Linear Algebra at the undergraduate level. It begins by introducing students to the methods for solving linear systems of equations and the calculus of matrices. Building upon these topics the abstract notions of a vector space and linear transformations are introduced. The equivalence of matrices under similarity and conjugation is studied with the aid of the notions of inner product spaces and eigenvectors and eigenvalues.

PREREQUISITES

Minimum grade of C- in MATH1840 or MATH1860. Students who enroll in MATH1890 but have not passed either prerequisite may be administratively dropped from the class.

TEXTBOOK

Linear Algebra and Its Applications, Books a la Carte Edition Plus MyMathLab with Pearson eText – Access Code Card — Edition: 5, by David C Lay, Steven R. Lay, Judi J. McDonald (ISBN: 9780321989925), Pearson.

GRADING AND EVALUATION

% Score	Grade
90-100	A range
80-89.99	B range
70-79.99	C range
60-69.99	D range
< 60	F

Note that minus and plus grades will be awarded for grades within 2.5% of the lower and upper ends of the given ranges respectively, e.g. B- for 80-82.49, B for 82.50-87.49, B+ for 87.5-89.99. Also note that there are not A+ grades at The University of Toledo.

Component	points
Homework	15%
Quizzes	15%
Three (3) Exams	45%
Final Exam	25%

ONLINE HOMEWORK

Homework for this course is online and is located at <https://mlm.pearson.com/> and is also linked from Blackboard. Late homework will have a 40% penalty. Students must purchase a MyMathLab Access Code.

QUIZZES

There will be weekly quizzes. The lowest two quiz scores will be dropped.

TESTS AND FINAL EXAM

There will be 3 tests one after each 4 weeks. Tentatively they will be held on February 16, March 22, and April 19. The final is comprehensive and will be held on **Tuesday April 30 2024, 10:15-12:15pm** in the regular classroom. Please note that the final exam may not be taken early under any circumstances in accordance with department policy.

IMPORTANT DATES

The instructor reserves the right to change the content of the course material if he perceives a need due to postponement of class caused by inclement weather, instructor illness, etc., or due to the pace of the course.

Last day to add/drop this class: Tuesday January 30, 2024

Last day to withdraw from this class with a grade of W: Friday March 22, 2024

MISSED CLASS POLICY

If circumstances occur in accordance with “The University of Toledo Missed Class Policy” (found at http://www.utoledo.edu/facsenate/misled_class_policy.html) result in a student missing a quiz, test, exam or other graded item, the student must contact the instructor in advance by phone, e-mail or in person, provide official documentation to back up his or her absence, and arrange to make up the missed item as soon as possible.

INSTITUTIONAL CLASSROOM ATTENDANCE POLICY

Please be aware that the university has implemented an attendance policy, which requires faculty to verify student participation in every class a student is registered at the start of each new semester/course. For this course, if you have not attended/participated in class (completed any course activities or assignments) within the first 14 days, I am required by federal law to report you as not attended. Unfortunately, not attending/participating in class impacts your eligibility to receive financial aid, so it is VERY important that you attend class and complete course work in these first two weeks. Please contact me as soon as possible to discuss options and/or possible accommodations if you have any difficulty completing assignments within the first two weeks.

ACADEMIC DISHONESTY

Any act of academic dishonesty as defined by the University of Toledo policy on academic dishonesty (found at <http://www.utoledo.edu/dl/students/dishonesty.html>) will result in an F in the course or an F on the item in question, subject to the determination of the instructor. In particular, tests, quizzes and exams must be entirely the student’s own work and any use of outside websites, apps, technology or persons to assist with completing these items will be considered academic dishonestly.

POLICY STATEMENT ON NON-DISCRIMINATION ON THE BASIS OF DISABILITY (ADA)

The University is an equal opportunity educational institution. Please read The University’s Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance. Students can find this policy along with other university policies listed by audience on the University Policy webpage (<http://www.utoledo.edu/policies/audience.html/#students>).

ACADEMIC ACCOMMODATIONS

The University of Toledo embraces the inclusion of students with disabilities. We are committed to ensuring equal opportunity and seamless access for full participation in all courses. For students who have an Accommodations Memo from the Office of Accessibility and Disability Resources, I invite you to correspond with me as soon as possible so that we can communicate confidentially about implementing accommodations in this course.

For students who have not established accommodations with the Office of Accessibility and Disability Resources and are experiencing disability access barriers or are interested in a referral to health care resources for a potential disability, please connect with the office by calling 419.530.4981 or sending an email to StudentDisability@utoledo.edu.

RELIGIOUS ACCOMODATIONS

A student is permitted to be absent, *without penalty*, for up to three days each academic semester to take holidays for reasons of faith or religious or spiritual belief system or to participate in organized activities conducted under the auspices of a religious denomination church, or other religious or spiritual organization.

Alternative accommodations will be provided to students who miss exams and/or other academic requirements because of such absences under the following circumstances:

- i. The student’s sincerely held religious belief or practice severely affects the student’s ability to take an exam or meet an academic requirement; and
- ii. the student submits a form through <https://forms.office.com/r/gBBCQkQj3H> (which includes a link to the non-exhaustive list of religious holidays/holy days) within 14 days after the first day of instruction; and
- iii. the Office of the Provost will send notification to each instructor indicating the specific dates for which the student will be absent; and
- iv. the student and faculty member agree on how and when the missed coursework and/or exam will be completed, which may be prior to or after the missed class, but must be completed before the end of the term.

GRIEVANCE PROCEDURE

A student may notify the institution of any grievance regarding the policy’s implementation using the 3364-71-05.1 Academic grievance procedure (https://www.utoledo.edu/policies/academic/undergraduate/pdfs/3364-71-05-1_AcademicGrievanceProcedure.pdf).

ACADEMIC AND SUPPORT SERVICES

Please follow this link to view a comprehensive list of Student Academic and Support Services (<http://www.utoledo.edu/studentaffairs/departments.html>) available to you as a student.

SAFETY AND HEALTH SERVICES FOR UT STUDENTS

Please use the following link to view a comprehensive list Campus Health and Safety Services (<http://www.utoledo.edu/offices/provost/utc/docs/CampusHealthSafetyContacts.pdf>) available to you as a student.

STUDENT PRIVACY

Federal law and university policy prohibits instructors from discussing a student's grades or class performance with anyone outside of university faculty/staff without the student's written and signed consent. This includes parents and spouses. For details, see the "Confidentiality of Student Records (FERPA)" section of the University Policy Page at <http://www.utoledo.edu/policies/academic/undergraduate/index.html>

OTHER UNIVERSITY POLICIES

Refer to the student handbook at <http://www.utoledo.edu/studentaffairs/pdfs/handbook.pdf>

RESOURCES

Free math tutoring on a walk-in basis is available in the Math Learning and Resources Center located in Rm B0200 in the lower level of Carlson Library (phone ext 2176). The Center operates on a walk-in basis. MLRC hours can be found at <http://www.math.utoledo.edu/mlrc/MLRC.pdf>

CLASS SCHEDULE

Chapter	1	Linear Equations in Linear Algebra		(total 10 hours)
	1.1	Systems of Linear Equations	(learning obj 2)	2
	1.2	Row Reduction and Echelon Forms	(learning obj 2)	1
	1.3	Vector Equations	(learning obj 1)	2
	1.4	The Matrix Equation $Ax = b$	(learning obj 2)	1
	1.5	Solution Sets of Linear Systems	(learning obj 2)	1
	1.7	Linear Independence	(learning obj 4)	1
	1.8	Introduction to Linear Transformations	(learning obj 5)	1
	1.9	The Matrix of a Linear Transformation	(learning obj 5)	1
Chapter	2	Matrix Algebra		(total 8 hours)
	2.1	Matrix Operations	(learning obj 3)	2
	2.2	The Inverse of a Matrix	(learning obj 3)	2
	2.3	Characterizations of Invertible Matrices	(learning obj 3)	1
	2.8	Subspaces of \mathbb{R}^n	(learning obj 4)	2
	2.9	Dimension and Rank	(learning obj 4)	1
Chapter	3	Determinants		(total 5 hours)
	3.1	Introduction to Determinants	(learning obj 6)	1
	3.2	Properties of Determinants	(learning obj 6)	2
	3.3	Cramer's Rule, Volume, and Linear Transformations	(learning obj 6)	2
Chapter	4	Vector Spaces		(total 9 hours)
	4.1	Vector Spaces and Subspaces	(learning obj 8)	2
	4.2	Null Spaces, Column Spaces, and Linear Transformations	(learning obj 5)	2
	4.3	Linearly Independent Sets; Bases	(learning obj 4)	1
	4.4	Coordinate Systems	(learning obj 9)	1
	4.5	The Dimension of a Vector Space	(learning obj 4)	1
	4.6	Rank	(learning obj 4)	1
	4.7	Change of Basis	(learning obj 9)	1
Chapter	5	Eigenvalues and Eigenvectors		(total 6 hours)
	5.1	Eigenvectors and Eigenvalues	(learning obj 7)	1
	5.2	The Characteristic Equation	(learning obj 7)	1
	5.3	Diagonalization	(learning obj 7)	2
	5.4	Eigenvectors and Linear Transformations	(learning obj 7)	1
	5.5	Complex Eigenvalues	(learning obj 7)	1
Chapter	6	Orthogonality and Least Squares		(total 2 hours)
	6.1	Inner Product, Length, and Orthogonality	(learning obj 1)	1
	6.2	Orthogonal Sets	(learning obj 1)	1
	6.3	Orthogonal Projections		(Op.)
	6.4	The Gram-Schmidt Process		(Op.)
		Total Hours		40

LEARNING OBJECTIVES

The successful Learning Algebra student should be able to:

1. **Vectors:** Utilize algebraic and geometric representations of vectors in \mathbb{R}^n and their operations, including addition, scalar multiplication and dot product. Determine the angle between vectors and the orthogonality of vectors.
2. **Systems of Linear Equations:** Solve systems of linear equations using Gauss-Jordan elimination to reduce to echelon form. Solve systems of linear equations using the inverse of the coefficient matrix when possible. Interpret existence and uniqueness of solutions geometrically.
3. **Matrix Algebra:** Perform common matrix operations such as addition, scalar multiplication, multiplication, and transposition.
4. **Linear Independence:** Recognize spanning sets and linear independence for vectors in \mathbb{R}^n . Prove elementary theorems concerning rank of a matrix and the relationship between rank and nullity.
5. **Linear Transformations:** For a given matrix write the corresponding linear transformation from \mathbb{R}^n to \mathbb{R}^m . Compute a transformation's kernel, image, nullity, and the rank. Write a linear transformation in terms of its matrix representation. Compute composition of linear transformations by multiplying their matrix representations.
6. **Determinants:** Use the determinant to find the inverse of a matrix. Describe how row and column operations affect the determinant. Compute the determinant of the product of matrices by multiplying the determinants.
7. **Eigenvalues and Eigenvectors:** Define eigenvalues and eigenvectors geometrically. Use characteristic polynomials to compute eigenvalues and eigenvectors. Use eigenspaces of matrices, when possible, to diagonalize a matrix.
8. **Vector Spaces:** Use axioms for abstract vector spaces over the real numbers to give examples (and non-examples) of abstract vector spaces such as subspaces of the space of all polynomials.
9. **Orthogonalization:** Recognize orthogonal and orthonormal bases, use Gram-Schmidt orthogonalization to find orthogonal and orthonormal bases, find orthogonal complements of sets, and projections of vectors.