

SAMPLE SYLLABUS

This document is published as an indication of what is typically taught in this course. Instructors have the responsibility of deciding on topics to be omitted, additional topics to be included and the emphasis, ordering and pacing of presentation.

Course Number: **MTH 309**

Course Title: **Introduction to Linear Algebra**

Credit Hours: **4.0**

Textbook: **D. Lay, *Linear Algebra and its Applications*, 2nd custom UB edition.**

2nd custom UB edition is identical with the standard 4th edition.

Prerequisites: MTH 142

Notes: This is a core course required for all math majors, although math majors make up a small fraction of the enrollment. In Fall 2010 the enrollment was approximately 2/3 engineering, 10% Computer Science, and lesser amounts from physics, math, economics, etc.

Instructors are encouraged to demonstrate the usefulness of technology (Maple) for applying the concepts of the course to nontrivial examples, including a selection of exercises marked [M] where technology is necessary.

This schedule is written for 13 weeks of instruction. In a typical semester there are 14 teaching weeks, thus some flexibility is built in.

Week	Sections	Topics
1	1.1 - 1.4	Systems of linear equations. Row reduction and echelon forms. Vector equations. The matrix equation $Ax=b$.
2	1.5 - 1.8	Solution sets of linear systems. Applications of linear systems. Linear independence. Linear transformations.
3	2.1 - 2.3	Matrix operations. The inverse of a matrix. Characterizations of invertible matrices.
4	2.8 - 2.9	Subspaces of \mathbb{R}^n . Dimension and rank. Midterm Exam I
5	3.1 - 3.3	Introduction to determinants. Properties of determinants. Cramer's rule, volume, and linear transformations.
6	4.1 - 4.2	Vector spaces and subspaces. Null spaces, column spaces, and linear transformations.
7	4.3 - 4.4	Linearly independent sets, bases. Coordinate systems.
8	4.5 - 4.6	Dimension of a vector space. Rank. Midterm Exam 2
9	5.1 - 5.2	Eigenvectors and eigenvalues. Characteristic equation.
10	5.3 - 5.5	Diagonalization. Eigenvectors and linear transformations. Complex eigenvalues.
11	6.1 - 6.3	Inner product, length, orthogonality. Orthogonal sets. Orthogonal projections.
12	6.4 - 6.5	Gram-Schmidt process. Least squares problems.
13	7.1 - 7.2	Diagonalization of symmetric matrices. Quadratic forms.

Student Learning Outcomes for MTH 309 Introduction to Linear Algebra

Assessment measures: weekly homework assignments, 2 midterm exams, final exam.

At the end of this course a student will be able to:	Assessment
<ul style="list-style-type: none"> - represent systems of linear equations in vector and matrix form - determine if a system of equations is consistent and whether it has a unique solution - solve systems of linear equations using Gauss-Jordan elimination 	HW #1, 2 Midterm 1 Final Exam
<ul style="list-style-type: none"> - perform matrix-vector multiplication and understand how this operation defines a linear transformation between \mathbb{R}^n and \mathbb{R}^m - add, multiply, and transpose matrices - determine whether a given matrix is invertible and compute its inverse if it exists - state and apply properties of matrix algebra 	HW #3 Midterm 1 Final Exam
<ul style="list-style-type: none"> - recognize which sets of vectors of \mathbb{R}^n form a subspace - find a basis of the null space and the column space of a matrix - compute the rank of a matrix and the dimension of the column space of a matrix 	HW #4 Midterm 1 Final Exam
<ul style="list-style-type: none"> - compute determinants of matrices both by cofactor expansion and by row reduction - use Cramer's rule to solve systems of equations and to compute inverses of matrices - compute areas of parallelograms and volumes of parallelepipeds using determinants - understand relationship between the determinant of a matrix and properties of the linear transformation represented by the matrix 	HW #5 Midterm 2 Final Exam
<ul style="list-style-type: none"> - understand the axiomatic definition of a vector space and know some examples of vector spaces other than \mathbb{R}^n (vector space of polynomials, vector space of matrices etc.) - recognize if a given function between vector spaces is a linear transformation - understand the notions of the kernel and the image of a linear transformation and their relationship to the null space and the column space of a matrix 	HW #6 Midterm 2 Final Exam
<ul style="list-style-type: none"> - compute bases of some simple vector spaces given a basis of a simple vector space - compute coordinates of a vector relative to a basis 	HW #7 Midterm 2 Final Exam
<ul style="list-style-type: none"> - compute the dimension of a vector space in some simple examples - compute dimensions of various subspaces defined by a matrix using the rank theorem 	HW #8 Midterm 2 Final Exam
<ul style="list-style-type: none"> - compute the characteristic polynomial of a matrix, find eigenvalues and eigenvectors of the matrix - determine if a given matrix is diagonalizable and compute its diagonalization - use diagonalization of a matrix to compute its powers 	HW #9, 10 Final Exam
<ul style="list-style-type: none"> - compute the inner product of vectors in \mathbb{R}^n - determine if a set of vectors in \mathbb{R}^n is orthogonal - compute the projection of a vector onto a subspace - orthogonalize a set of vectors using the Gram-Schmidt process - solve least square problems 	HW #11, 12 Final Exam
<ul style="list-style-type: none"> - compute orthogonal diagonalization of symmetric matrix - compute the matrix representing a quadratic form - determine if a given quadratic form is positive definite, negative definite, or indefinite 	Final Exam

The table below indicates to what extent this course reflects each of the learning objectives of the undergraduate mathematics program. A description of learning objectives is available online at http://www.math.buffalo.edu/undergraduate/undergrad_programs.shtml.

Computational Skills:	Analytical Skills:	Practical Problem Solving:	Research Skills:	Communication Skills:
extensively	moderately	moderately	little or not at all	moderately