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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**

Textbook: **D. Lay, S. Lay, J. McDonald *Linear Algebra and its Applications*, 3nd custom UB edition.**

3nd custom UB edition is the same as the standard 5th edition.

Prerequisites: MTH 142

Notes: While this is a core course required for all math majors, usually over 70% of students taking MTH 309 are engineering majors. The course should cover several applications of linear algebra in natural sciences, engineering and computer science. Students taking this course should be introduced to computer based tools for performing linear algebra computation (row reduction, matrix multiplication, singular value decomposition etc.). Homework assignments should include a selection of exercises marked [M] where computer based computations are necessary.

This schedule is written for 13 weeks of instruction. A typical semester has14 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, 1.7, 1.6, 1.10	Solution sets of linear systems. Linear independence of vectors. Applications of systems of linear equations and linear models.
3	1.8, 1.9, 2.1, 2.2	Introduction to linear transformations. Matrix of a linear transformation. Matrix operations. The inverse of a matrix.
4	2.3, 2.7, 2.8, 2.9	Characterizations of invertible matrices. Applications to computer graphics. Subspaces of R^n. Dimension and rank.
5	3.1 - 3.3	Introduction to determinants. Properties of determinants. Cramer's rule, volume, and linear transformations. **Midterm Exam 1**
6	4.1 - 4.3	Vector spaces and subspaces. Null spaces, column spaces, and linear transformations. Linearly independent sets, bases.
7	4.4 - 4.7	Coordinate systems. Dimension of a vector space. Rank. Change of basis.
8	4.8, 4.9, 5.1, 5.2	Applications to difference equations and Markov chains. Eigenvectors and eigenvalues. Characteristic equation.
9	5.3, 5.4, 5.6	Diagonalization. Eigenvectors and linear transformations. Discrete dynamical systems. **Midterm Exam 2**
10	*5.8*, 6.1, 6.2	*Iterative estimates of eigenvalues (optional).* Inner product, length, orthogonality, orthogonal sets.
11	6.3 - 6.5	Orthogonal projections. The Gram-Schmidt process. Least squares problems.
12	6.6, 7.1, 7.2	Applications to linear models. Diagonalization of symmetric matrices. *Quadratic forms(optional)*
13	7.4, 7.5	Singular value decomposition. Applications to image processing and statistics.

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
– represent systems of linear equations in vector and matrix form – determine if a system of equations is consistent and whether is has a unique solution – solve systems of linear equations using Gauss-Jordan elimination	HW #1, 2 Midterm 1 Final Exam
– perform matrix-vector multiplication and understand how this operation defines a linear transformation between R^n and 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
– recognize which sets of vectors of 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
– 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
– understand the axiomatic definition of a vector space and know some examples of vector spaces other than R^n (vector space of polynomials, vector space of matrices etc.) – recognize if a given function between vector spaces is a linear transformations – understand the notions of the kernel and image of a linear transformation and their relationship to the null space and columns space of a matrix	HW #6 Midterm 2 Final Exam
– compute bases of and dimensions of some simple vector spaces – compute coordinates of a vector relative to a basis – compute the change of coordinates matrix from one basis to another – compute dimensions of various subspaces defines by a matrix using the rank theorem	HW #7 Midterm 2 Final Exam
- 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 #8, 9 Final Exam
- compute the inner product of vectors in R^n - determine if a set of vectors in R^n is orthogonal - compute the projection of a vector onto a subspace - orthogonalize a set set of vectors using the Gram-Schmidt process - solve least square problems	HW #10, 11 Final Exam
- compute orthogonal diagonalization of symmetric matrix - compute the singular value decomposition of a matrix	HW #12 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