SYLLABUS FOR “[FALL/SPRING]” SEMESTER, 20xx

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<tr>
<th>Course Title:</th>
<th>ELEMENTARY LINEAR ALGEBRA</th>
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<tr>
<td>Instructor:</td>
<td>“[Instructor Name]”</td>
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<tr>
<td>Credit Hours:</td>
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<td>Office:</td>
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<tr>
<td>Course Number:</td>
<td>MATH 1890-00x</td>
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<td>Hours:</td>
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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
MATH 1840, MATH1860, or MATH1940

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](http://www.math.utoledo.edu/mlrc/MLRC.pdf)

GRADING AND EVALUATION
Syllabus should describe the methods of evaluation whether quizzes, exams or graded assignments. There should be at least two one-hour in class exams. If quiz scores are not used as a portion of the grade, there should be three one-hour exams. As mentioned above there is the expectation that counted in the grade will be an evaluation of at least one project assignment. A description of a grading method that includes the proportion that each evaluating method counts toward the grade should be described. If the grading method uses a grading scale it should be clearly stated. In scheduling quizzes and exams it should be kept in mind that the last day to add/drop the class is the end of the second week of classes and the last day to withdraw from the class is the end of the tenth week. By these dates students like to have some measure of their progress in the class.

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.

MIDTERM EXAM:
FINAL EXAM:

OTHER DATES
The last day to drop this course is ____________________
The last day to withdraw from this course is ____________________

MISSED CLASS POLICY
If you miss any graded item, then this item may only be made up in accordance with the University’s
Missed Class Policy. This policy requires that you contact me in advance by phone, e-mail or in person, provide official documentation for the absence, and make up the missed item as soon as possible. You can find the University’s Missed Class Policy at http://www.utoledo.edu/fac senate/missed_class_policy.html

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.

NON-DISCRIMINATION POLICY
The University of Toledo is committed to a policy of equal opportunity in education, affirms the values and goals of diversity.

STUDENT DISABILITY SERVICES
The University will make reasonable academic accommodations for students with documented disabilities. Students should contact the Student Disability Services (Rocket Hall 1820; 419.530.4981; studentdisabilityvs@utoledo.edu) as soon as possible for more information and/or to initiate the process for accessing academic accommodations. For the full policy see: http://www.utoledo.edu/offices/student-disability-services/sam/index.html

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

CLASS SCHEDULE
Syllabus should provide a list of sections to be covered and should indicate the material that might be covered on each in-class examination. It is advisable to provide at least a tentative exam schedule. In formulating a schedule for the class enough time should be budgeted to cover the following topic thoroughly.

COURSE CONTENT:
### Chapter 1 Linear Equations in Linear Algebra (total 10 hours)

1.1 Systems of Linear Equations (2)  
1.2 Row Reduction and Echelon Forms (2)  
1.3 Vector Equations (1)  
1.4 The Matrix Equation $Ax = b$ (2)  
1.5 Solution Sets of Linear Systems (2)  
1.7 Linear Independence (4)  
1.8 Introduction to Linear Transformations (5)  
1.9 The Matrix of a Linear Transformation (5)  

### Chapter 2 Matrix Algebra (total 8 hours)

2.1 Matrix Operations (3)  
2.2 The Inverse of a Matrix (3)  
2.3 Characterizations of Invertible Matrices (3)  
2.8 Subspaces of $\mathbb{R}^n$ (4)  
2.9 Dimension and Rank (4)  

### Chapter 3 Determinants (total 5 hours)

3.1 Introduction to Determinants (6)  
3.2 Properties of Determinants (6)  
3.3 Cramer's Rule, Volume, and Linear Transformations (6)  

### Chapter 4 Vector Spaces (total 9 hours)

4.1 Vector Spaces and Subspaces (8)  
4.2 Null Spaces, Column Spaces, and Linear Transformations (5)  
4.3 Linearly Independent Sets; Bases (4)  
4.4 Coordinate Systems (9)  
4.5 The Dimension of a Vector Space (4)  
4.6 Rank (4)  
4.7 Change of Basis (9)  

### Chapter 5 Eigenvalues and Eigenvectors (total 6 hours)

5.1 Eigenvectors and Eigenvalues (7)  
5.2 The Characteristic Equation (7)  
5.3 Diagonalization (7)  
5.4 Eigenvectors and Linear Transformations (7)  
5.5 Complex Eigenvalues (7)  

### Chapter 6 Orthogonality and Least Squares (total 2 hours)

6.1 Inner Product, Length, and Orthogonality (1)  
6.2 Orthogonal Sets (1)  
6.3 Orthogonal Projections  
6.4 The Gram-Schmidt Process  

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Total: 40 hours lecture + 3 hours exams = 43 hours

*The numbers in parentheses refer to students outcome and 1-8 are the essential outcomes.

*In Fall semesters there are 43 lecture for a MWF class.
LEARNING OBJECTIVES
The successful Linear Algebra students 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.