COLLIN COUNTY COMMUNITY COLLEGE
COURSE SYLLABUS

COURSE NUMBER: MATH 2318
COURSE TITLE: Linear Algebra
CREDIT HOURS: 3
LECTURE HOURS: 3
LAB HOURS: 0
ASSESSMENTS: None
PREREQUISITE: MATH 2414 or MATH 2419
COREQUISITE: None

COURSE DESCRIPTION: Introduces and provides models for application of the concepts of vector algebra. Topics include finite dimensional vector spaces and their geometric significance; representing and solving systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion; matrices; determinants; linear transformations; quadratic forms; eigenvalues and eigenvector; and applications in science and engineering.

SUPPLIES: Graphing calculator required

STUDENT LEARNING OUTCOMES:

Upon successful completion of this course, students will:
1. Be able to solve systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion. (EQ)
2. Be able to carry out matrix operations, including inverses and determinants. (EQ)
3. Demonstrate understanding of the concepts of vector space and subspace. (CS)
4. Demonstrate understanding of linear independence, span, and basis. (CT/CS)
5. Be able to determine eigenvalues and eigenvectors and solve problems involving eigenvalues. (EQ)
6. Apply principles of matrix algebra to linear transformations. (CT)
7. Demonstrate application of inner products and associated norms. (CS)

COURSE REQUIREMENTS: Attending lectures, completing assignments and exams.

COURSE FORMAT: Lecture and guided practice.

METHOD OF EVALUATION: A minimum of four proctored exams and a proctored comprehensive final exam will be given. The final exam must count at least as much as any regular exam. Homework and/or quizzes may be used in place of one exam or in addition to
exams. The weight of each of these components of evaluation will be specified in the individual instructor’s addendum to this syllabus. All out-of-class course credit, including home assignments, service-learning, etc. may not exceed 25% of the total course grade; thus, at least 75% of a student’s grade must consist of proctored exams, and no student may retake any of these exams.

ATTENDANCE POLICY: Attendance is expected of all students. If a student is unable to attend, it is his/her responsibility to contact the instructor to obtain assignments. Please see the schedule of classes for the last day to withdraw from the course with a grade of W.

RELIGIOUS HOLY DAYS: In accordance with section 51.911 of the Texas Education Code, the college will allow a student who is absent from class for the observance of a religious holy day to take an examination or complete an assignment scheduled for that day within a reasonable time. A copy of the state rules and procedures regarding holy days and the form for notification of absence from each class under this provision are available from the Admissions and Records Office. Please refer to the current Collin Student Handbook.

ADA STATEMENT: Collin College will adhere to all applicable federal, state and local laws, regulations and guidelines with respect to providing reasonable accommodations as required to afford equal educational opportunity. It is the student’s responsibility to contact the ACCESS Office, SCC-D140 or 972.881.5898, (V/TDD 972.881.5950) to arrange for appropriate accommodations. See the current Collin student Handbook for additional information.

ACADEMIC ETHICS: Please see section 7-2.2 of the Collin Student Handbook. Contact the Dean of Students at 972.881.5771 for the student disciplinary process and procedures.

COURSE CONTENT: Proofs and derivations will be assigned at the discretion of the instructor. The student will be responsible for knowing all definition and statements of theorems for each section outlined in the following modules.

MODULE 1: Systems of Linear Equations, Matrices, Determinants

The student will be able to:

1. Recognize a linear equation in \( n \) variables.
2. Find a parametric representation of a solution set.
3. Determine whether a system of linear equations is consistent or inconsistent.
4. Use back-substitution and Gaussian elimination to solve a system of linear equations.
5. Determine the size of a matrix and write an augmented or coefficient matrix from a system of linear equations.
6. Use matrices and Gaussian elimination with back-substitution to solve a system of linear equations.
7. Use matrices and Gauss-Jordan elimination to solve a system of linear equations.
8. Solve a homogeneous system of linear equations.
9. Set up and solve a system of equations to fit a polynomial function to a set of data points, as well as to represent a network.
10. Add, subtract matrices and multiply a matrix by a scalar.
11. Multiply two matrices.
12. Use matrices to solve a system of linear equations.
13. Use properties of matrix operations to solve matrix equations.
14. Find the transpose of a matrix, the inverse of a matrix (if it exists).
15. Use an inverse matrix to solve a system of linear equations.
16. Factor a matrix into a product of elementary matrices.
17. Find and use an \( LU \)-factorization of a matrix to solve a system of linear equations.
18. Use a stochastic matrix to measure consumer preference (optional).
19. Use matrix multiplication to encode and decode messages.
20. Use matrix algebra to analyze Leontief input-output models (optional).
21. Use the method of least squares to find the least squares regression line for a set of data (optional).
22. Find the determinants of a 2 x 2 matrix and a triangular matrix.
23. Find the minors and cofactors of a matrix and use expansion by cofactors to find the determinant of a matrix.
24. Use elementary row and column operations to evaluate the determinant of a matrix.
25. Recognize conditions that yield zero determinants.
26. Find the determinant of a matrix product and a scalar multiple of a matrix.
27. Find the determinant of an inverse matrix and recognize equivalent conditions for a nonsingular matrix.
28. Find the determinant of the transpose of a matrix.
29. Find the adjoint of a matrix and use it to find its inverse.
30. Use Cramer's Rule to solve a system of linear equations.
31. Use determinants to find the area, volume, and the equations of lines and planes.

**MODULE 2: Vector Spaces, Inner Product Spaces**

The student will be able to:

1. Represent a vector as a directed line segment.
2. Perform basic vector operations in \( \mathbb{R}^2 \).
3. Perform basic vector operations in \( \mathbb{R}^n \).
4. Write a vector as a linear combination of other vectors.
5. Define a vector space and recognize some important vector spaces.
6. Show that a given set is not a vector space.
7. Determine whether a subset \( W \) of a vector space \( V \) is a subspace of \( V \).
8. Determine subspaces of \( \mathbb{R}^n \).
9. Write a linear combination of a set of vectors in a vector space \( V \).
10. Determine whether a set \( S \) of vectors in a vector space \( V \) is a spanning set of \( V \).
11. Determine whether a set of vectors in a vector space \( V \) is linearly independent.
12. Recognize bases in the vector spaces \( \mathbb{R}^n \), \( M_{m,n} \), and \( P_n \).
13. Find the dimension of a vector space.
14. Find a basis for the row, a basis for the column space, and the rank of a matrix.
15. Find the nullspace of a matrix.
16. Find the solution of a consistent system $A\mathbf{x} = \mathbf{b}$ in the form $\mathbf{x} = p + x_n$.
17. Find a coordinate matrix relative to a basis in $\mathbb{R}^n$.
18. Find the transition matrix from the basis $B$ to the basis $B'$ in $\mathbb{R}^n$.
19. Represent coordinates in general n-dimensional spaces.
20. Determine whether a function is a solution of a differential equation and find the general solution of a given differential equation.
21. Use the Wronskian to test a set of solutions of a linear homogeneous differential equation for linear independence (optional).
22. Identify and sketch the graph of a conic or degenerate conic section and perform a rotation of axes (optional).
23. Find the length of a vector and find a unit vector.
24. Find the distance between two vectors.
25. Find a dot product and the angle between two vectors, determine orthogonality and verify the Cauchy-Schwarz Inequality, the triangle inequality, and the Pythagorean Theorem.
26. Determine whether a function defines an inner product, and find the inner product of two vectors in $\mathbb{R}^n$, $M_{m,n}$, $P_n$ and $C[a,b]$.
27. Find an orthogonal projection of a vector onto another vector in an inner product space.
28. Show that a set of vectors is orthogonal and forms an orthonormal basis, and represent a vector relative to an orthonormal basis.
29. Apply the Gram-Schmidt orthonormalization process.
30. Find the cross product of two vectors in $\mathbb{R}^3$ (optional).
31. Find the linear or quadratic least squares approximation of a function (optional).
32. Find the $n$th-order Fourier approximation of a function (optional).

**MODULE 3: Linear Transformations, Eigenvalues and Eigenvectors**

The student will be able to:

1. Find the image and preimage of a function.
2. Show that a function is a linear transformation, and find a linear transformation.
3. Find the kernel of a linear transformation.
4. Find a basis for the range, the rank, and the nullity of a linear transformation.
5. Determine whether a linear transformation is one-to-one or onto.
6. Determine whether two vector spaces are isomorphic.
7. Find the standard matrix for a linear transformation.
8. Find the standard matrix for the composition of a linear transformations and find the inverse of an invertible linear transformation.
9. Find the matrix for a linear transformation relative to a nonstandard basis.
10. Find and use a matrix for a linear transformation.
11. Show that two matrices are similar and use the properties of similar matrices.
12. Identify linear transformations defined by reflections, expansions, contractions, or shears in $\mathbb{R}^2$ (optional).
13. Use a linear transformation to rotate a figure in $\mathbb{R}^3$ (optional).
14. Verify eigenvalues and corresponding eigenvectors.
15. Find the eigenvalues and corresponding eigenspaces.
16. Use the characteristic equation to find eigenvalues and eigenvectors, and find the eigenvalues and eigenvectors of triangular matrix.
17. Find the eigenvalues of similar matrices, determine whether a matrix is diagonalizable, and find a matrix $P$ such that $P^{-1}AP$ is diagonal.
18. Find, for a linear transformation $T : V \rightarrow V$, a basis $B$ for $V$ such that the matrix for $T$ relative to $B$ is diagonal.
19. Recognize, and apply properties of symmetric and orthogonal matrices.
20. Find an orthogonal matrix $P$ that orthogonally diagonalizes a symmetric matrix $A$.
21. Use a matrix equation to solve a system of first-order linear differential equations (optional).
22. Find the matrix of quadratic form and use the Principal Axes Theorem to perform a rotation of axes for a conic and a quadratic surface (optional).
23. Solve a constrained optimization problem (optional).