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Semester effective:

Mathematics (MATH) 2125 Linear Algebra (4 Units) CSU

Prerequisite: Successful completion of Mathematics 2120 with a grade of 'C' or better

Prerequisite knowledge and skills: Before entering the course, the student should be able to:

1. Understand the use of functional notation
2. Plot and interpret graphs of functions
3. Recognize the relationship between functions and their inverses graphically and algebraically
4. Identify numbers as belonging to specified sets
5. Solve linear equations and inequalities in one variable
6. Add, subtract, multiply, and divide rational algebraic expressions, and reduce to lowest terms
7. Solve and graph linear inequalities in two variables
8. Solve linear systems of equations in two or three variables algebraically
9. Analyze and solve application problems requiring the use of linear systems of equations in two or three variables
10. Evaluate determinants
11. Apply transformations to the graphs of functions and relations
12. Solve and apply equations including rational, linear, polynomial, exponential, absolute value, radical, and logarithmic functions
13. Manipulate and simplify a trigonometric expression
14. Prove trigonometric identities
15. Differentiate algebraic, trigonometric, exponential, logarithmic and hyperbolic functions using differentiation formulas
16. Find the integrals of basic functions
17. Determine if a function is continuous at a real number
18. Find the equation of a tangent line to a function
19. Apply functions to real world applications

Hours and Unit Calculations:

64 hours lecture. (128 Outside-of-class Hours); (192 Total Student Learning Hours) 4 Units

Catalog Description: This course develops the techniques and theory needed to solve and classify systems of linear equations. Solution techniques include row operations, Gaussian elimination, and matrix algebra. Investigates the properties of vectors in two and three dimensions, leading to the notion of an abstract vector space. Vector space and matrix theory are presented including topics such as inner products, norms, orthogonality, eigenvalues, eigenspaces, and linear transformations. Selected applications of linear algebra are included.

Type of Class/Course: Degree Credit

Textbook: Kuttler, K. and Farah, I. *A first course in linear algebra*. Lyryx Learning Inc.  
<https://lyryx.com/first-course-linear-algebra/>

Additional Required Materials: Graphing Calculator (TI-83/84)

Course Objectives:

By the end of the course, a successful student will be able to:

1. Find solutions of systems of equations using various methods appropriate to lower division linear algebra;
2. Use bases and orthonormal bases to solve problems in linear algebra;
3. Find the dimension of spaces such as those associated with matrices and linear transformations;
4. Find eigenvalues and eigenvectors and use them in applications; and
5. Prove basic results in linear algebra using appropriate proof-writing techniques such as linear independence of vectors; properties of subspaces; linearity, injectivity and subjectivity of functions; and properties of eigenvectors and eigenvalues.

Course Scope and Content:

- Unit I            Systems of Linear Equations and Matrices
- A. Introduction to systems of linear equations
  - B. Solve systems of equations using Gaussian and Gauss-Jordan elimination
  - C. Matrices and Matrix Algebra
  - D. Finding the inverse of a matrix, invertibility, transpose
  - E. Relationship between coefficient matrix invertibility and solutions to a system of linear equations and the inverse matrices
  - F. Special Matrices: diagonal, triangular, and symmetric
- Unit II            Determinants
- A. Evaluating determinants
  - B. Determinants and their properties
  - C. Determinants and row reduction
  - D. Cramer's Rule
- Unit III            $\mathbb{R}^n$
- A. Vector algebra for  $\mathbb{R}^n$
  - B. Geometric meaning of vector addition and scalar multiplication
  - C. Real vector space and subspaces
  - D. Spanning Set of Vectors
  - E. Linearly independent set of vectors
  - F. Basis and dimension of a vector space
  - G. Matrix-generated spaces: row space, column space, null space, rank, nullity
  - H. Change of Basis
  - I. Orthogonal and orthonormal bases: Gram-Schmidt process
  - J. Dot product, norm of a vector, angle between vectors, orthogonality of two vectors in  $\mathbb{R}^n$
  - K. Inner products on a real vector space
  - L. Angle and orthogonality in inner-product spaces

- Unit V            Linear Transformations
- A. Properties of linear transformations
  - B. Linear transformations, kernel and range, and inverse linear transformations
  - C. Matrices of general linear transformations
  - D. One to one and onto transformations
  - E. Isomorphisms
- Unit VI            Spectral Theory
- A. Eigenvectors, eigenvalues, and eigenspace
  - B. Diagonalization
  - C. Orthogonal diagonalization of symmetric matrices
- Unit VII           Vector Spaces
- A. Spanning sets
  - B. Linear independence
  - C. Subspaces and Basis, dimension of a vector space
  - D. Isomorphisms
  - E. Matrix of a linear transformation

#### Learning Activities Required Outside of Class

The students in the class will spend a minimum of 8 hours per week outside of the regular class time doing the following:

1. Completing the assigned reading from the textbook
2. Completing homework assignments
3. Studying
4. Skill practice
5. Watching instructional videos on how to use technology to solve problems

#### Methods of Instruction

1. Lecture demonstrations and sample problems done by instructor
2. Recorded videos that demonstrate how to utilize a graphing calculator to solve select problems
3. Individual work with calculators and computers
4. Student presentations of completed problems

#### Methods of Evaluation

1. Homework and/or projects where students demonstrate their mastery of the learning objectives and their ability to analyze problems and present complete solutions both with and without a calculator
2. Quizzes
3. Exams

#### Supplemental Data:

T.O.P. Code:	170100: Mathematics, General
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Sam Priority Code:	E: Non-Occupational
Funding Agency:	Y: Not Applicable(funds not used)
Distance Learning:	Not Applicable
Program Status:	Program Applicable
Noncredit Category:	Y: Not Applicable, Credit Course
Special Class Status:	N: Course is not a special class
Basic Skills Status:	N: Course is not a basic skills course
Prior to College Level:	Y: Not applicable
Cooperative Work Experience:	N: Is not part of a cooperative work experience education program
Eligible for Credit by Exam:	E: Credit By Exam
Eligible for Pass/No Pass:	C: Pass/No Pass
Discipline:	Mathematics