College of San Mateo
Course Outline

___ New Course
X Course Revision

Date: April 30, 2007

Department: Mathematics **Number:** 270

Course Title: Linear Algebra **Units:** 3

Hours/Week: **Lecture:** 3 **Scheduled Lab:** 0 **By Arrangement**: 1

Length of Course

X Semester-long

___ Short course (Number of weeks___)

___ Open entry/Open exit

Grading

x___Letter

___ Credit/No Credit

___ Grade Option (letter or Credit/No **C**edit)

1. **Prerequisite** (Attach Enrollment Limitation Validation Form.)

Math 252 or equivalent.

2. **Corequisite** (Attach Enrollment Limitation Validation Form.)

None

3. **Recommended Preparation** (Attach Enrollment Validation Form.)

Concurrent enrollment in Math 231 or an equivalent; Reading 400 or 405.

4. **Catalog Description** (Include prerequisites/corequisites/recommended preparation.)

Math 270 Linear Algebra (3) *Three lecture hours plus one hour by arrangement per week. Prerequisite: Math 252 or equivalent. Recommended Preparation: completion or concurrent enrollment in Math 231 or an equivalent; READ 400 or 405.* Vectors and matrices applied to linear equations and linear transformations; real and inner product spaces. (CSU/UC)(CAN MATH 26)

5. **Class Schedule Description** (Include prerequisites/corequisites/recommended preparation.)

Math 270 LINEAR ALGEBRA Vectors and matrices applied to linear equations and linear transformations; real and inner product spaces. Plus one hour by arrangement per week. Extra supplies may be required. Prerequisite:MATH 252 or equivalent.*Recommended Preparation:READ 400 or 405;* Completion or concurrent enrollment in Math 231. (CSU/UC)(CAN MATH 26)

6. Student learning Outcomes (identify 1-6 student learning outcomes using active verbs).)

The student will:

A. Develop analytical thinking

- Answer the question, “What is the problem really asking?” and identify the pertinent given information.
- Break complex problems into manageable smaller problems.
- See relationships between concepts, notational representation, and problem situations.
- Solve problems that cannot be reduced to algorithms

B. Demonstrate resourcefulness in problem solving

- Choose appropriate methods
- Synthesize appropriate strategies, techniques or information from prerequisite courses
- Use geometric context as a guide.
- Recognize and analyze erroneous or impossible solutions

C. Verify assertions expressed in mathematical language

- Write, read, and understand mathematics as written in mathematical symbolism and wording.
- Form and assess mathematical conjectures
- Verify identities
- Apply counter examples

D. Synthesize ideas expressed in mathematical language

- Read mathematical writing with understanding.
- Demonstrate a basic understanding of proof
- Communicate arguments clearly

E. Develop confidence in ability to employ mathematical strategies.

7. Course Objectives (Identify 5-8 expected learner outcomes using active verbs.)

Students can:

- Parametrically construct the solution space of a linear system using Gaussian elimination.
- Use elementary row operations to reduce a matrix to row echelon form.
- Successfully employ all of the standard operations with matrices and vectors.
- Judge when a function is or is not a linear transformation.
- Given a linear transformation,

- Recognize the standard matrix (if the domain and range are of the form R^n).
- Construct the null space as a span of vectors.
- Construct the range space as a span of vectors.
- Assess if it is invertible, and, if it is, construct the inverse.
- Assess if it is one to one and/or onto.

- Construct elementary matrices corresponding to elementary row operations and can use both to construct the inverse of an invertible square matrix.
- Judge if a set of vectors is linearly independent or dependent.
- Construct a basis for a given vector space.
- Calculate the dimension of a given vector space.
- Judge if a subset of a given vector space is a subspace.
- Assess whether a given set and field with addition and scalar multiplication is or is not a vector space.
- Calculate the new representations of a vector or standard matrix under a change of basis.
- Calculate the determinant of a square matrix and use it to judge the linear independence of row or columns and judge invertibility.
- Apply the basic properties of the determinant.
- Calculate a determinant by expansion by majors.
- Apply the concept of matrix similarity.
- Calculate the eigenvalues and construct a basis for the eigenspaces of a matrix or linear transformation.
- Construct the diagonal decomposition of a square matrix or else explain why the matrix can not be diagonalized.
- Judge when a given (vector,vector) to scalar operation is or is not an inner product.
- Express vectors and the representation of a linear transformation in terms of a new basis.
- Construct orthonormal bases of R^n.

8. **Course Content** (Brief but complete topical outline of the course that includes major subject areas [1-2 pages]. Should reflect all course objectives listed above. In addition, you may attach a sample course syllabus with a timeline.)

- Linear systems
- Gaussian elimination, Gauss-Jordan elimination
- Row echelon form and reduced row echelon form
- Solution space of a linear system and parametric representation of solution space.
- Linear independence and linear dependence
- Matrix representation of a linear system
- Basic matrix algebra
- Linear transformations from R^n to R^m.

- Standard matrix of a linear transformation in R^n
- Standard basis of R^n
- Null space and range space
- One to one and onto
- Row rank, column rank, rank
- Determinants
- Transpose
- Elementary row operations
- Elementary matrices
- Inverse of a matrix
- Inverse of a linear transformation
- Transformations of the plane
- Dimension theorem
- Basis
- Span
- Vector space
- Subspace
- Vector spaces of polynomials and matrices
- Change of basis
- Eigenvalues, eigenvectors, and eigenspaces
- Characteristic equation
- Diagonalization
- Inner product
- Orthogonality
- Orthonormal basis
- Orthogonal matrices

9. Representative Instructional Methods (Describe instructor-initiated teaching strategies that will assist students in meeting course objectives. Include examples of out-of-class assignments, required reading and writing assignments, and methods for teaching critical thinking skills.)

A. Out-of-class assignments: problem sets requiring students to compute, solve, construct, prove, and assess.

- o Example: Construct the inverse of the linear transformation from R^2 to R^2, T(x,y) = (2x-y,3x+2y).

- o Example: x1, x2, and x3 are linearly independent vectors in vector space V. T is a one to one linear transformation from V to vector space W. Prove that T(x1), T(x2), T(x3) are linearly independent.

B. Required reading assignments: assignments requiring the student to read sections of the (linear algebra) textbook and/or selected materials supplied by the teacher.

- o Example: Read the section in the textbook on the null space and range space of a linear transformation.

- Example: Read the instructor’s handout on using matrix diagonalization to solve a system of differential equations.

C. Required writing assignments:

D. Students will be required to explain concepts and compose logical arguments in writing assignments.

- Example: x1, x2, and x3 are linearly independent vectors in vector space V. T is a one to one linear transformation from V to vector space W. Prove that T(x1), T(x2), T(x3) are linearly independent.

E. Methods for teaching critical thinking: Assignments (see 1 and 3 above) that require students to calculate, judge, assess, construct, and solve. Also students will be encouraged to discuss and debate conceptual questions in classroom discussion. And of course students are always encouraged to question whatever the teacher or other students do.

- Example: T(x,y) = (x + y, 3x + 3y) is a linear transformation from R^2 to R^2. (a) Is T one to one? Explain why or why not. (b) Is T onto? Explain why or why not.

- Example: T is a linear transformation from R3 to R3 in homogeneous coordinates. T acts to reflect the point (x,y) (what is this in homogeneous coordinates?) across the line y = 2x + 1. Calculate the standard matrix for T. Explain why your standard matrix works.

- Example: x1, x2, and x3 are linearly independent vectors in vector space V. T is a one to one linear transformation from V to vector space W. Prove that T(x1), T(x2), T(x3) are linearly independent.

F. Other methods: Collaborative work in or out of class. Work using computer software.

10. Representative Methods of Evaluation (Describe measurement of student progress toward course objectives. Courses with required writing component and/or problem-solving emphasis must reflect critical thinking component. If skills class, then applied skills.)

A. Problem sets – These consist of sets of exercises assigned frequently. Questions may require solution (find the solution to the system of linear equations), calculation (calculate the determinant), proof, construction of linear algebra objects (constuct a basis), judgements about linear algebra objects (is this a vector space?), and explanation of why.

B. Quizes – These are short examinations on the areas covered in the problem set.

C. Exams – Longer examinations. May be cumulative.

D. Writing assignments – Require extended logical argument and explanation of mathematical assertions, concepts, and processes.

12. Representative Text Materials (With few exceptions, texts need to be current. Include publication dates.)

Linear Algebra and its Applications, 3rd Ed., David C. Lay, 2003, Addison-Wesley.

Linear Algebra with Applications, 7th Ed., Steven J. Leon, 2005, Prentice Hall.

Prepared by: ______________________________
(Signature)

Submission Date: ______________________________