COLLEGE OF THE DESERT

Course Code MATH-002B

Course Outline of Record

1. Course Code: MATH-002B
2. a. Long Course Title: Linear Algebra
   b. Short Course Title: LINEAR ALGEBRA
3. a. Catalog Course Description:
   This course is a standard introductory course in linear algebra. Topics include vectors in Rn, matrices and systems of linear equations, determinants, vector spaces, linear independence, linear transformations, eigenvalues, eigenvectors, and diagonalization of certain quadratic forms.
   b. Class Schedule Course Description:
   MATH-002B is the traditional sophomore level Linear Algebra course with Calculus 1B prerequisite.
   c. Semester Cycle (*if applicable*): N/A
   d. Name of Approved Program(s):
   - MATHEMATICS Associate in Science for Transfer Degree (AS-T)
4. Total Units: 4.00 Total Semester Hrs: 108.00
   Lecture Units: 3 Semester Lecture Hrs: 54.00
   Lab Units: 1 Semester Lab Hrs: 54.00
   Class Size Maximum: 35 Allow Audit: No
   Repeatability No Repeats Allowed
   Justification 0
5. Prerequisite or Corequisite Courses or Advisories:
   Course with requisite(s) and/or advisory is required to complete Content Review Matrix (CCForm1-A)
   Prerequisite: MATH 001B
6. Textbooks, Required Reading or Software: *(List in APA or MLA format.)*
   a. Anton, Howard (2010). *Elementary Linear Algebra - Applications Version* (10th /e). Wiley. ISBN: 9780470432051
   College Level: Yes
   Flesch-Kincaid reading level: 12
   b. Fraleigh and Beauregard (1994). *Linear Algebra* (3rd /e). Pearson Education.
   College Level: Yes
   Flesch-Kincaid reading level: 12
   c. Strang, Gilbert (2005). *Linear Algebra and its Applications* (4th /e). Brooks/Cole. ISBN: 9780030105678
   College Level: Yes
   Flesch-Kincaid reading level: 12
7. Entrance Skills: *Before entering the course students must be able:*
   a.
   Evaluate definite and indefinite integrals using a variety of integration formulas and techniques.
   - MATH 001B - Evaluate definite and indefinite integrals using a variety of integration formulas and techniques;

   b.
   Apply integration to areas and volumes, and other applications such as work or length of a curve.
   - MATH 001B - Apply integration to areas and volumes, and other applications such as work or length of a curve;

   c.
   Evaluate improper integrals.

- MATH 001B - Evaluate improper integrals;

d.
Apply convergence tests to sequences and series.

- MATH 001B - Apply convergence tests to sequences and series;

e.
Represent functions as power series.

- MATH 001B - Represent functions as power series; and

f.
Graph, differentiate and integrate functions in polar and parametric form.

- MATH 001B - Graph, differentiate and integrate functions in polar and parametric form.

8. Course Content and Scope:

Lecture:

1. Techniques for solving systems of linear equations including Gaussian and Gauss-Jordan elimination and inverse matrices;
2. Matrix algebra, invertibility, and the transpose;
3. Relationship between coefficient matrix invertibility and solutions to a system of linear equations and the inverse matrices;
4. Special matrices: diagonal, triangular, and symmetric;
5. Determinants and their properties;
6. Vector algebra for $\mathbf{R}^n$;
7. Real vector space and subspaces;
8. Linear independence and dependence;
9. Basis and dimension of a vector space;
10. Matrix-generated spaces: row space, column space, null space, rank, nullity;
11. Change of basis;
12. Linear transformations, kernel and range, and inverse linear transformations;
13. Matrices of general linear transformations;
14. Eigenvalues, eigenvectors, eigenspace;
15. Diagonalization including orthogonal diagonalization of symmetric matrices;
16. Inner products on a real vector space;
17. Dot product, norm of a vector, angle between vectors, orthogonality of two vectors in $\mathbf{R}^n$;
18. Angle and orthogonality in inner product spaces; and
19. Orthogonal and orthonormal bases: Gram-Schmidt process.

Lab: *(if the "Lab Hours" is greater than zero this is required)*

1. Applications of linear transformations using appropriate mathematical tools, including technology.
2. Guided practice in writing mathematical proofs.

9. Course Student Learning Outcomes:

1. Define Euclidean spaces of arbitrary dimension as generalizations of our 3 dimensional space, including concepts of length, sums, and products.

2. Use matrices to solve systems of equations.

3.
Define a vector space as a more abstract generalization of a Euclidian space (e.g. function vector spaces) and significant subspaces and use linear transformations as tools to analyze vector spaces.

4.
Demonstrate critical and logical thinking, by frequent use of deductive reasoning in mathematics, in the context of vector spaces.

10. Course Objectives: *Upon completion of this course, students will be able to:*
    a. Find solutions of systems of equations using various methods appropriate to lower division linear algebra including Gaussian and Gauss-Jordan elimination and inverse matrices;
    b. Perform the Algebra of matrices including finding inverses;
    c. Compute the determinant of a matrix and understand the properties of the determinant function;
    d. Demonstrate an understanding of vectors and vector operations including the norm, the dot product, and the cross product;
    e. Demonstrate an understanding of the concept of a general vector space and a subspace of a vector space;
    f. Demonstrate an understanding of linear dependence and independence and demonstrate whether a set of vectors is dependent or independent;
    g. Demonstrate an understanding of the concept of a spanning set of vectors and determine if a given set of vectors spans a given vector space;
    h. Demonstrate an understanding of inner product spaces;
    i. Demonstrate an understanding of the concept of a linear transformation and how to find a matrix that represents a linear transformation given bases for the vector spaces involved;
    j. Test a transformation for linearity and determine the kernel, the range, the rank and the nullity of a linear transformation;
    k. Demonstrate an understanding of the significance of two matrices being similar;
    l. Demonstrate an understanding of the significance of an orthonormal basis of a vector space and compute such a basis using the Gram-Schmidt process;
    m. Use bases and orthonormal bases to solve problems in linear algebra;
    n. Find the dimension and a basis for spaces such as those associated with matrices and linear transformations;
    o. Find eigenvalues and eigenvectors of a linear transformation and use them in applications;
    p. Diagonalize matrices including orthogonal diagonalization of symmetric matrices;
    q. Prove basic results in linear algebra using appropriate proof-writing techniques such as linear independence of vectors; properties of subspaces; linearity, injectivity and surjectivity of functions; and properties of eigenvectors and eigenvalues; and
    r. Apply studied principles and skills to new situations in addition to situations that mirror those on the homework and those shown in class.

11. Methods of Instruction: *(Integration: Elements should validate parallel course outline elements)*
    a. Discussion
    b. Laboratory
    c. Lecture

12. Assignments: *(List samples of specific activities/assignments students are expected to complete both in and outside of class.)*
    In Class Hours: 108.00
    Outside Class Hours: 108.00
    a. In-class Assignments
       1. Attend classroom lectures and take notes.
       2. Participate in classroom discussions to review, analyze, diagnose, and evaluate various methods of solution used in homework assignments.
       3. Complete laboratory assignments using appropriate mathematical tools.
       4. Complete examinations involving problems that apply studied principles to new situations.
    b. Out-of-class Assignments
       1. Read textbooks and supplementary assignments.
       2. Complete assigned homework including problem solving, exercises to improve skills and mathematical understanding.
       3. Complete examinations involving problems that apply studied principles to new situations.

13. Methods of Evaluating Student Progress: *The student will demonstrate proficiency by:*
    - Written homework
      Performance on regularly assigned homework assignments

- Computational/problem solving evaluations
- Mid-term and final evaluations
  a. Performance on chapter examinations b. Performance on a 2-hour comprehensive final examination
- Student participation/contribution
- Student preparation

14. Methods of Evaluating: Additional Assessment Information:

15. Need/Purpose/Rationale -- *All courses must meet one or more CCC missions.*
    IGETC Area 2: Mathematical Concepts and Quantitative Reasoning
    A: Mathematic
    CSU GE Area B: Physical and its Life Forms(mark all that apply)
    B4 - Mathematics/Quantitative Thinking
    PO-GE C4.b - Language & Rationality (Communication & Analytical Thinking)
    Gather, assess, and interpret relevant information.
    Apply logical and critical thinking to solve problems; explain conclusions; and evaluate, support, or critique the thinking of others.
    IO - Scientific Inquiry
    Analyze quantitative and qualitative information to make decisions, judgments, and pose questions.
    IO - Global Citizenship - Scientific & Technological Literacy
    Utilize quantitative expression in a variety of contexts. These would include units of measurement, visual representations, and scales and distributions.
    Synthesize, interpret, and infer, utilizing information, data, and experience to solve problems, innovate, and explore solutions.

16. Comparable Transfer Course

University System	Campus	Course Number	Course Title	Catalog Year

17. Special Materials and/or Equipment Required of Students:

18. Materials Fees: ☐ Required Material?

Material or Item	Cost Per Unit	Total Cost

19. Provide Reasons for the Substantial Modifications or New Course:

    Change SLO's to align with number of units.

20. a. Cross-Listed Course *(Enter Course Code)*: *N/A*
    b. Replacement Course *(Enter original Course Code)*: *N/A*

21. Grading Method *(choose one)*: Letter Grade Only

22. MIS Course Data Elements
    a. Course Control Number [CB00]: CCC000328559
    b. T.O.P. Code [CB03]: 170100.00 - Mathematics, General
    c. Credit Status [CB04]: D - Credit - Degree Applicable
    d. Course Transfer Status [CB05]: A = Transfer to UC, CSU
    e. Basic Skills Status [CB08]: 2N = Not basic skills course
    f. Vocational Status [CB09]: Not Occupational
    g. Course Classification [CB11]: Y - Credit Course
    h. Special Class Status [CB13]: N - Not Special

i. Course CAN Code [CB14]: *N/A*
j. Course Prior to College Level [CB21]: Y = Not Applicable
k. Course Noncredit Category [CB22]: Y - Not Applicable
l. Funding Agency Category [CB23]: Y = Not Applicable
m. Program Status [CB24]: 1 = Program Applicable

Name of Approved Program *(if program-applicable)*: MATHEMATICS
Attach listings of Degree and/or Certificate Programs showing this course as a required or a restricted elective.)

23. Enrollment - Estimate Enrollment
First Year: 0
Third Year: 0

24. Resources - Faculty - Discipline and Other Qualifications:
a. Sufficient Faculty Resources: Yes
b. If No, list number of FTE needed to offer this course: *N/A*

25. Additional Equipment and/or Supplies Needed and Source of Funding.
N/A

26. Additional Construction or Modification of Existing Classroom Space Needed. *(Explain:)*
N/A

27. FOR NEW OR SUBSTANTIALLY MODIFIED COURSES
Library and/or Learning Resources Present in the Collection are Sufficient to Meet the Need of the Students Enrolled in the Course: Yes

28. Originator John Learned Origination Date 10/20/17