El Camino College

COURSE OUTLINE OF RECORD - Official

I. GENERAL COURSE INFORMATION

Subject and Number: Mathematics 270
Descriptive Title: Differential Equations with Linear Algebra

Course Disciplines: Mathematics

Division: Mathematical Sciences

Catalog Description: This course consists of a study of first-order ordinary differential equations, systems of linear equations, matrices, determinants, vector spaces, linear transformations, linear second-order ordinary differential equations, power series solutions, numerical methods, Laplace transforms, eigenvalues, eigenvectors, and systems of linear differential equations and applications.

Conditions of Enrollment:

Prerequisite

Mathematics 220 with a minimum grade of C

Course Length: [X] Full Term [ ] Other (Specify number of weeks):
Hours Lecture: 5.00 hours per week [ ] TBA
Hours Laboratory: 0 hours per week [ ] TBA
Course Units: 5.00

Grading Method: Letter
Credit Status Associate Degree Credit

Transfer CSU: [X] Effective Date: Prior to July 1992
Transfer UC: [X] Effective Date: Prior to July 1992

General Education:

El Camino College:

4B – Language and Rationality – Communication and Analytical Thinking
Term: Other: Approved

6 – Mathematics Competency
Term: Other: Approved

CSU GE:

B4 - Mathematics/Quantitative Thinking
Term: Other: Approved

IGETC:

2A - Mathematical Concepts and Quantitative Reasoning
Term: Other: Approved

II. OUTCOMES AND OBJECTIVES

A. COURSE STUDENT LEARNING OUTCOMES (The course student learning outcomes are listed below, along with a representative assessment method for each. Student learning outcomes are not subject to review, revision or approval by the College Curriculum Committee)

1. UNDERSTANDING CONCEPTS: Students will explain and demonstrate the key concepts of linear algebra, including determinants, vector spaces and linear transformations.
2. SOLVING PROBLEMS: Students will use differential equations and linear algebra to solve a variety of problems, including application problems.
3. GRAPHS: Students will use graphical techniques to solve differential equations or systems of differential equations.
4. PROOFS: Students will analyze and construct proofs relevant to differential equations and linear algebra.

The above SLOs were the most recent available SLOs at the time of course review. For the most current SLO statements, visit the El Camino College SLO webpage at http://www.elcamino.edu/academics/slo/.

B. Course Student Learning Objectives (The major learning objective for students enrolled in this course are listed below, along with a representative assessment method for each)

1. Identify the type of given differential equation and select and apply the appropriate analytical technique for the solution of first order and selected higher order differential equations: separable; exact; first-order linear; two special types of second-order; linear, higher-order differential equations with constant coefficients; Cauchy-Euler equations, and nonhomogenous equations.

   Other exams
2. Create and analyze mathematical models using ordinary differential equations.

   Essay exams
3. Verify solutions of differential equations.

   Quizzes
4. Apply the existence and uniqueness theorems for ordinary differential equations.

   Objective Exams
5. Solve differential equations using the following numerical methods, including: Euler method, Taylor series methods, and Runge-Kutta methods.

   Other exams
6. Find power series solutions to differential equations.

   Objective Exams
7. Perform operations on matrices and prove theorems involving matrices.

   Other exams
8. Prove theorems about determinants and solve problems involving determinants.

   Essay exams
9. Find solutions of systems of equations using various methods appropriate to lower division linear algebra.

   Objective Exams

10. Solve linear systems of equations, both dependent and independent.

    Objective Exams

11. Determine whether a given set constitutes a vector space or a subspace of a known vector space.

    Essay exams

12. Determine whether a given set of vectors or functions is independent.

    Objective Exams

13. Determine whether a set of vectors spans a given vector space.

    Objective Exams

14. For some common vector spaces find a basis and the dimension, and prove the result.

    Essay exams

15. Find the dimension of spaces such as those associated with matrices and linear transformations.

    Objective Exams

16. Use the Gram-Schmidt procedure to find an orthonormal basis for a given subspace.

    Other exams

17. Use bases and orthonormal bases to solve problems in linear algebra.

    Objective Exams

18. Determine whether or not a given operator is a linear transformation.

    Objective Exams

19. Carry out a variety of proofs and problems involving the kernel, range, composition and inverse of linear transformations.

    Essay exams

20. Work with differential operator notation.

    Objective Exams

21. Find eigenvalues and eigenvectors and use them in applications.

    Objective Exams

22. Solve linear systems of ordinary differential equations using eigenvectors.

    Other exams

23. Determine the Laplace transform and inverse Laplace transform of various functions using the definition, tables and shifting theorems.

    Objective Exams

24. Solve differential equations using Laplace transforms.

    Objective Exams

25. Prove basic results in linear algebra using appropriate proof-writing techniques. These include linear independence of vectors; properties of subspaces; linearity, injectivity and surjectivity of functions; and properties of eigenvalues and eigenvectors.

    Essay exams

26. Use a computer algebra system to solve problems in differential equations and linear algebra; and solve application problems.

    Laboratory reports

III. OUTLINE OF SUBJECT MATTER (Topics are detailed enough to enable a qualified instructor to determine the major areas that should be covered as well as ensure consistency from instructor to instructor and semester to semester.)

Lecture or Lab	Approximate Hours	Topic Number	Major Topic
Lecture	10	I	INTRODUCTION TO DIFFERENTIAL EQUATIONS A. Introduction B. Separable equations C. Homogeneous equations D. Exact equations E. First-order linear equations F. Applications of first order differential equations such as circuits, mixture problems, population modeling, orthogonal trajectories, and slope fields G. Two special types of second-order equations H. Existence and uniqueness of solutions
Lecture	15	II	MATRICES AND DETERMINANTS A. Systems of linear equations B. Homogeneous systems C. Matrices and vectors D. Vector algebra for $\mathbf{R}^n$ E. Matrix multiplication F. Inner product and length G. Some special matrices H. Definition of determinant I. Determinants and their properties J. Cofactors K. Cramer's Rule L. The inverse of a matrix M. Proofs involving matrix algebra, e.g. A(B+C) = AB + AC N. Proofs involving determinants O. Techniques for solving systems of linear equations including Gaussian and Gauss-Jordan elimination and inverse matrices P. Matrix algebra, invertibility, and the transpose Q. Relationship between coefficient matrix invertibility and solutions to a system of linear equations and inverse matrices R. Special matrices: diagonal, triangular, and symmetric
Lecture	15	III	VECTOR SPACES AND LINEAR TRANSFORMATIONS A. Real and complex vector spaces and subspaces B. Linear independence and spanning C. Wronskian D. Basis and dimension of a vector space E. Diagonalization including orthogonal diagonalization of symmetric matrices

			F. Dot product, norm of a vector, angle between two vectors, orthogonality of two vectors in $\mathbf{R}^n$ G. Orthogonal and orthonormal bases: Gram-Schmidt process H. Matrix-generated spaces: row space, column space, null space, rank, nullity I. Change of basis J. Linear Transformations, kernel and range, composition, and inverse linear transformations K. Properties of linear transformations L. Proofs involving vector spaces and linear transformations M. Differential operators N. Matrices of general linear transformations
Lecture	15	IV	SECOND ORDER and HIGHER ORDER LINEAR DIFFERENTIAL EQUATIONS A. Introduction to linear differential equations and fundamental solutions B. Polynomial operators C. Complex solutions D. Equations with constant coefficients E. Cauchy-Euler equations F. Nonhomogeneous equations G. Solving differential equations using the method of undetermined coefficients H. Solving differential equations using the mehod of variation of parameters I. Applications of higher order differential equations such as the harmonic oscillator and circuits
Lecture	5	V	EIGENVALUES, EIGENVECTORS AND SYSTEMS OF DIFFERENTIAL EQUATIONS A. Eigenvalues, eigenvectors and eigenspace B. Systems of ordinary differential equations
Lecture	10	VI	POWER SERIES SOLUTIONS DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS A. Construction of Taylor Series B. Series solutions of differential equations with ordinary points C. Series solutions of differential equations with singular points D. The Euler method, Taylor Series methods, Runge-Kutta methods of finding numerical solutions of differential equations
Lecture	10	VII	LAPLACE TRANSFORM A. The Laplace Transform B. Functions of exponential order C. Properties of Laplace Transforms D. Inverse transforms E. Applications of differential equations F. Functions with discontinuities

Lecture	10	VIII	VIII. Problem Solving in Differential Equations and Linear Algebra Using a Computer Algebra System and Applications to Engineering and Physics
Total Lecture Hours		90	
Total Laboratory Hours		0	
Total Hours		90	

IV. PRIMARY METHOD OF EVALUATION AND SAMPLE ASSIGNMENTS

A. **PRIMARY METHOD OF EVALUATION:**

Problem solving demonstrations (computational or non-computational)

B. **TYPICAL ASSIGNMENT USING PRIMARY METHOD OF EVALUATION:**

Solve the nonhomogeneous equation

(x^2)y' + 2xy' - 2y = 6x, given that x > 0

using the method of undetermined coefficients.

C. **COLLEGE-LEVEL CRITICAL THINKING ASSIGNMENTS:**

1. If S is any finite set of elements in a vector space V that contains the zero element of V, prove that S is a linearly dependent set of vectors.
2. Prove that a linear transformation T is one-to-one if and only if the kernel of T consists of the zero vector alone.

D. **OTHER TYPICAL ASSESSMENT AND EVALUATION METHODS:**

Objective Exams
Other exams
Quizzes
Homework Problems

V. INSTRUCTIONAL METHODS

Demonstration
Discussion
Group Activities
Lecture
Other (please specify)
Use of a computer algebra system.

Note: In compliance with Board Policies 1600 and 3410, Title 5 California Code of Regulations, the Rehabilitation Act of 1973, and Sections 504 and 508 of the Americans with Disabilities Act, instruction delivery shall provide access, full inclusion, and effective communication for students with disabilities.

VI. WORK OUTSIDE OF CLASS

Study
Answer questions
Skill practice
Required reading
Problem solving activities

Estimated Independent Study Hours per Week: 10

VII. TEXTS AND MATERIALS

A. **UP-TO-DATE REPRESENTATIVE TEXTBOOKS**
Jerry Farlow, James E. Hall, Jean Marie McDill, Beverly H. West,. Differential Equations and Linear Algebra. 2nd ed. Prentice Hall, 2007.

B. **ALTERNATIVE TEXTBOOKS**

C. **REQUIRED SUPPLEMENTARY READINGS**

D. **OTHER REQUIRED MATERIALS**
Graphing Calculator

VIII. CONDITIONS OF ENROLLMENT

A. Requisites (Course and Non-Course Prerequisites and Corequisites)

Requisites	Category and Justification
Course Prerequisite Mathematics-220	Sequential

B. Requisite Skills

Requisite Skills
1. Calculate partial derivatives and double integrals. MATH 220 - Calculate partial derivatives and use the chain rule to find partial or total derivatives of functions of severable variables.

C. Recommended Preparations (Course and Non-Course)

Recommended Preparation	Category and Justification

D. Recommended Skills

Recommended Skills

E. Enrollment Limitations

Enrollment Limitations and Category	Enrollment Limitations Impact

Course created by H. Jones on 01/01/1967.

BOARD APPROVAL DATE:

LAST BOARD APPROVAL DATE: 12/14/2015

Last Reviewed and/or Revised by Gregory Fry on 09/26/2015

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