MATH 0033 - DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA

SECTION A

1. **Division:** Sciences & Mathematics
2. **Subject Code:** MATH
3. **Course Number:** 0033
4. **Course Title:** DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA
5. **Semester of First Offering:** SPRING 2015

SECTION B General Course Information

1.Units: 6.0 **Variable Units:** N/A

2.This Course is: Degree-Applicable Credit - Transferable

3A. Cross-List: **3B. Formerly:**

Course Format and Duration

4. Standard Term Hours per Week		**5. Standard Term Total Semester Hours**	
Lecture/Discussion:	6	Lecture/Discussion:	108
Lab:		Lab:	
Activity:		Activity:	
By Arrangement:		By Arrangement:	
Total Hours per Week:	6	**Total Hours :**	108

6. Minimum hours per week of independent work done outside the class: 12

Course Preparation - (Supplemental form B required)

7a. Prerequisite(s): (Course and/or other preparation/experience that is REQUIRED to be completed previous to enrollment in this course.)

Completion of MATH 31 with grade of "C" or better

7b. Co-requisite(s): (Courses and/or other preparation that is REQUIRED to be taken concurrently with this course.)

7c. Advisory: (MINIMUM preparation RECOMMENDED in order to be succesful in this course. Also known as "Course Advisory".)

Completion of MATH 32 with grade of "C" or better strongly recommended

Catalog Description And Other Catalog Information:

8. Repeatability: **Not Repeatable**

Please note: Repeatability does not refer to repeating courses because of substandard grades or a lapse of time since the student took the course. A course may be repeated only if the course content differs each time it is offered and the student who repeats it is gaining an expanded educational experience as stipulated in Title V.

- ☐ Skills or proficiencies are enhanced by supervised repetition and practice within class periods.
- ☐ Active participatory experience in individual study or group assignments is the basic means by which learning objectives are attained.
- ☐ Course content differs each time it is offered.

Explanation for above repeatability selection:

9a. Grading Option: Standard Grade

9b. Catalog Description:

First and second order ordinary differential equations, linear differential equations, numerical methods and series solutions, Laplace transforms, modeling and stability theory, systems of linear differential equations, matrices, determinants, vector spaces, linear transformations, orthogonality, eigenvalues and eigenvectors.

Course Outline Information

10. Student Performance Objectives: (Performance objectives for all credit courses must indicate that students will learn critical thinking and will be able to apply concepts at college level.Performance objectives must be related to items listed in Section 11.)

1. solve first order differential equations analytically, numerically, and graphically;
2. apply the existence and uniqueness theorem for differential equations;
3. solve higher order differential equations;
4. construct a basis for the solution space of a differential equation;
5. use differential equations to create and analyze mathematical models;
6. apply Green's theorem to solve a differential equation;
7. perform basic operations on matrices;
8. use an augmented matrix and Gaussian elimination to solve a corresponding system of linear equations;
9. apply the inverse matrix method to solve a system of linear equations;
10. apply Cramer's rule to solve a system of linear equations;
11. verify that the axioms of a vector space, subspace, and inner product are satisfied for a variety of sets including: n-dimensional space, polynomials, matrices, continuous and differentiable functions;
12. apply the definition, the wronskian, and the determinant to determine the independence/dependence of vectors in a vector space;
13. construct the nullspace from a given matrix;
14. apply the Rank-Nullity theorem to determine the dimension of a vector space;
15. apply the Gram-Schmidt procedure to generate a set of orthogonal and orthonormal vectors that span a given space;
16. determine vector space bases and orthonormal bases and use in problem solving;
17. verify that a transformation is linear;
18. construct the kernel and range of a linear transformation;
19. apply eigenvalues, diagonalization and variation of parameters to solve a system of differential equations;
20. construct a matrix exponential function for a system of differential equations;
21. examine the phase plane for generating a qualitative representation of the solution to a system of nonlinear differential equations;
22. use Laplace transforms to determine the solutions to a differential equation with initial value conditions;
23. solve differential equations with forcing functions involving the unit step function and forcing functions involving the Dirac delta function;
24. apply the convolution integral to solve appropriate differential equations;
25. assess the need for the appropriate shifting theorems and apply when appropriate to solve a differential equation;
26. solve differential equations using power series methods including Frobenius solutions;
27. examine Legendre and Bessel differential equations and their solutions.

11. Course Content Outline: (Provides a comprehensive, sequential outline of the course content, including all major subject matter and the specific body of knowledge covered.)

I. First Order Differential Equations
A. Geometry of First Order Differential Equations including Existence and Uniqueness Theorem
B. Slope Fields including equilibrium solutions, Isoclines and concavity changes
C. Separation of Variables
D. Integrating Factors
E. Bernoulli Differential Equations
F. Homogeneous First-Order Differential Equations
G. Exact Differential Equations
H. Applications to First-Order Differential Equations
I. Numerical Techniques
II. Elements of Linear Algebra
A. Vector Spaces
B. Vectors specifically from R^n
C. Subspaces
D. Spanning Sets
E. Linear dependence and linear independence
F. Wronskian
G. Bases and Dimension
H. Change of Basis
I. Row and Column and Null Spaces
J. The Rank-Nullity Theorem
K. Invertible Matrices
L. Inner Product Spaces including the norm of a vector and Cauchy-Schwarz Inequality
M. Angles between vectors in R^n and orthogonality using inner product
N. Orthogonal Basis and Orthonormal Basis (Gram-Schmidt Process)
III. Linear Transformations and Linear Differential Operators
A. Matrix of a Transformation
B. Kernel and Range of Linear Transformation
C. General Rank-Nullity Theorem
D. Inverse Transformations
E. Isomorphisms
F. Eigenvalues and Eigen Vectors and Eigen Spaces
G. Diagonalization
H. Matrix Exponential Function
I. Orthogonal Diagonalization
J. Quadratic and Jordan Canonical Forms
IV. Higher-Order Linear Differential Equations
A. Phase Plane
B. Homogeneous Constant Coefficient Differential Equations
C. Method of Undetermined Coefficients
D. Variation of Parameters
E. Applications of Higher-Order Differential Equations
V. Laplace Transformations
A. Inverse Laplace Transformations
B. Shifting Theorems
C. Unit Step Function
D. Dirac Delta Function
E. Convolution Integral
VI. Series Solutions to Differential Equations
A. Ordinary Points and Singular Points
B. The Legendre Equation
C. Frobenius Theory
D. Bessel's Equation of Order p

VII. Matrices and Systems of Linear Equations
A. Matrix definition and notation including dimension, transpose, diagonal, triangular, symmetric, skew-symmetric
B. Matrix Algebra including sum and difference, product (including dot product definition)
C. Augmented Matrix
D. Consistent and Inconsistent systems
E. Row operations and Reduced Row Echelon form
F. Gaussian Elimination
G. Inverse Matrix
H. LU Factorization
I. Determinant including definition and properties
J. Cofactor Expansion
VIII. Systems of Linear Differential Equations
A. Vector Formulation
B. Fundamental Solutions Set and Fundamental Matrix
C. Nondefective and Defective Coefficient Matrices
D. Variation of Parameters
E. Application (such as Spring & Mass Systems and mixing problem)
F. Matrix Exponential Function

12. Typical Out-of-Class Assignments: (Credit courses **require** two hours of independent work outside of class for each lecture hour, less lab/activity classes. List type of assignments including library assignments.)

a. Reading Assignments: (Submit at least 2 examples.)

Example 1: Read in the textbook about the axioms of a vector space. Come to class prepared to discuss the subtle nature of these axioms.

Example 2: Read in your textbook (and research online) slope fields of the form D(y)=f(x,y) including isoclines, equilibrium solutions, and concavity.

b. Writing, Problem Solving or Performance: (Submit at least 2 examples)

Example 1: Sketch the slope field and some representative solution curves for the differential equation D(y)=y(y-1).

Example 2: Use technology to graph the slope field and connect the solution with the algebraic calculations of isoclines, equilibrium solutions, and concavity.

c. Other (Term projects, research papers, porfolios, etc.)

13. Required Materials:

a. All textbooks, resources and other materials used in this course are college level?

☑ Yes
☐ No

b. Representative college-level textbooks (for degree applicable courses) or other print materials:

Book 1:

Author:	Gilbert Strang
Title:	Differential Equations and Linear Algebra
Publisher:	Wellesley-Cambridge
Date of Publication:	2014
Edition:	First

c. Other materials and/or supplies required of students:

14.Check all Instructional methods used to present course content:

☑ Lecture
☑ Discussion Semminar
☑ Lab
☑ Directed Study
☐ Activity
☐ Distance Education (requires supplemental form)
☐ Work Experience
☐ Tutoring

Other:

Give detailed examples of teaching methodology that relate to the course performance objectives:

Example 1: The students and instructor will engage in interactive discussion concerning whether P3 with certain restrictions constitutes a vector space. This will be accomplished by measuring P3 with restrictions against the axioms that constitute a vector space.

Example 2: The instructor will direct the student to review power series representations of functions from the previous calculus course. The instructor will then guide the student to synthesize this background material to the power solution technique of solving differential equations.

15. Methods of Assessing Student Learning

15a. Methods of Evaluation:

☐ Essay Exam
☑ Objective Exam
☑ Projects
☑ Class Discussion
☐ Reports
☑ Problem Solving Exam
☐ Skill Demonstration
☐ Other

15b. (All courses must provide for measurement of student performance in terms of stated student performance objectives, Area 10, and culminate in a formal recorded grade based on uniform standards. Submit at least 2 examples.)

Example 1 - Write the linear first order differential equation dy/dx + p(x)y = q(x) in the form Mdx + Ndy = 0 and use the techniques of solving an exact differential equation to find the proper integrating factor. What does this tell you about all linear first order differential equations?

Example 2: Prove that P3 is a vector space by verifying that the set P3 satisfies each of the axioms for a vector space. This problem is graded for completeness and accuracy. Students need to verify each of the ten vector space axioms.

SECTION C

1. Program Information:

- ☑ In an approved program
- ☐ Part of a new program
- ☐ Not part of an approved program

2. TOP Code Information

Program Title: Mathematics, General 170100

3. Course SAM Code:

- ☐ A - Apprenticeship Course
- ☐ B - Advanced Occupational
- ☐ C - Clearly Occupational
- ☐ D - Possibly Occupational
- ☑ E - Non-Occupational

4. Faculty Minimum Qualifications/Degrees:

Mathematics

Comments:

SECTION D

General Education Information:

1. College Associate Degree GE Applicability:

Communication & Analytic Thinking
Math Competency

2. CSU GE Applicability:

B-4 Mathematics/Quantitative Reasoning

3. IGETC Applicability:

2: Mathematical Concepts & Quantitative Reasoning

4. CAN : MATH 910S Differential Equations and Linear Algebra

5. LDTP:

SECTION E

1. Articulation Information: (Required for Transferable Courses Only)

- ☑ CSU Transferable
- ☑ UC Transferable
- ☐ CSU/UC Major Requirement.

If CSU/UC major requirement, list campus and major. (Note: Must be lower division)

2. List at least one community college and its comparable course. If requesting CSU and/or UC transferability also list a CSU/UC campus and comparable lower division course

Allan Hancock College: MATH 184 Linear Algebra and Differential Equations
Cal Poly Pomona: MAT 224 Elementary Linear Algebra and Differential Equations
San Jose State University: MATH 123 Differential Equations and Linear Algebra
UC Berkeley: Math 54 Linear Algebra and Differential Equations

SECTION F

Planning and Resources: Please address the areas below:

1. Evidence of Need or Potential: recommendations of advisory committee, connection to existing or planned degrees/certificates, or regional/national developments, transfer university requirements.

Required for all math, physics, and engineering majors.

2. Appropriateness to Mission: connection to basic skills, transfer, career technical education, or lifelong learning; relationship

Transfer level math course.

3. Place in Program/Department: relationship to student learning outcomes identified by program, connection to general education, or articulation with other institutions.

Meets GE applicability for Math Competency and Communication and Analytical Thinking. Course includes all four math program SLO's. (Equations and Expressions, Visual Models, Applied Problems, Communication).

4. Availability of Faculty and Facilities: minimum qualifications to teach course, special training for instructors, or long-term physical impact of course.

All math faculty members meet the minimum qualifications to teach this course. No special training would be required.

5. Potential Impact on Resources: impact on library, computer support, transportation, equipment, or other needs

No additional resources are needed since we have the classroom space and technology already available.

SECTION G

1. Maximum Class Size (recommended): 35

2. If recommended class size is not standard, then provide rationale: