COURSE OUTLINE

Course Number	Course Title	Credits
MAT 252	**Differential Equations**	**4**
Hours: Lecture/Lab/Other	**Co- or Pre-requisite**	**Implementation Semester & Year**
4 lecture	**MAT152 or equivalent course with a minimum C grade or consultation with the mathematics chair or course coordinator.**	**Spring 2022**

Catalog description:
Topics covered include solutions of ordinary differential equations including existence and uniqueness theorems, qualitative, numerical, and analytical methods of equations of first and second order, Cauchy-Euler equations, solutions by infinite series, the Laplace transform, systems of equations, and applications to modeling.

General Education Category:
Goal 2: Mathematics

Course coordinator:
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Required texts & Other materials:
Elementary Differential Equations, William F. Trench, https://digitalcommons.trinity.edu/mono/8

Course Student Learning Outcomes (SLO):

Upon successful completion of this course the student will be able to:

1. Identify and classify various types of differential equations. [Supports ILG #2, 11, PLO #1 - 4]
2. Develop and interpret slope fields for first order differential equations. [Supports ILG #2, 11, PLO #1 - 4]
3. Calculate general and particular solutions of first order differential equations by qualitative, numerical, and analytical methods, which include separation of variables, homogeneous equations, exact equations, integrating factor, and Bernoulli methods. [Supports ILG #2, 11, PLO #1 - 4]
4. Determine whether unique solutions are guaranteed to exist. [Supports ILG #2, 11, PLO #1 - 4]
5. Create and solve equations that model physical problems using appropriate methods. [Supports ILG #2, 11, PLO #1 - 4]
6. Calculate general and particular solutions of second order linear differential equations by various methods, which include reduction of order, undetermined coefficients, variation of parameters, and solutions by series. [Supports ILG #2, 11, PLO #1 - 4]
7. Define and use Laplace transforms to solve differential equations. [Supports ILG #2, 11, PLO #1 - 4]
8. Solve systems of first order linear equations using differential operator, Laplace transform, and matrix methods including finding eigenvalues and eigenvectors and interpreting solutions of linear systems. [Supports ILG #2, 11, PLO #1 - 4]
9. Use technology to solve differential equations and systems numerically and visualize, interpret, and communicate the results. [Supports ILG #2, 11, PLO #1 - 4]

Course-specific Institutional Learning Goals (ILG):

Institutional Learning Goal 2. Mathematics. Students will use appropriate mathematical and statistical concepts and operations to interpret data and to solve problems.
Institutional Learning Goal 11. Critical Thinking: Students will use critical thinking skills understand, analyze, or apply information or solve problems.

Program Learning Outcomes for Mathematics AS (PLO)

1. Apply a range of mathematical skills spanning fundamental concepts to more advanced mathematical concepts.
2. Apply quantitative knowledge, including the required technological skills and theoretical knowledge.
3. Demonstrate critical thinking skills to solve real world problems using mathematical modeling.
4. Communicate methods of solutions and results to problems using mathematical language and notation.

Units of study in detail – Unit Student Learning Outcomes:

Unit I Introduction to Differential Equations [Supports Course SLOs #1, 2, 9]

Learning Objectives

The student will be able to:

- Classify differential equations.
- Verify that a function is a solution to a differential equation or an initial value problem.
- Analyze phase lines to find equilibrium solutions of autonomous first-order differential equations, determine their stability, and determine the general behavior of other solutions.
- Create both by hand and using software, and use slope fields to sketch solution curves for first order differential equations.

Unit II First Order Differential Equations [Supports Course SLOs #3, 4, 5]

Learning Objectives

The student will be able to:

- State and use the existence and uniqueness theorem for first order initial value problems.
- Apply Picard's Theorem to determine if a first-order initial value problem has a unique solution.
- Apply the techniques of separation of variables, homogeneous equations, exact equations, integrating factor, and Bernoulli to solve differential equations.
- Derive and solve differential equations that model motion in one direction, mixtures, and population growth.
- Determine if two families of curves are orthogonal trajectories of one another and find the orthogonal trajectory of a given family of curves.

Unit III Linear Differential Equations of Higher Order [Supports Course SLO #6]

Learning Objectives

The student will be able to:

- State and interpret the existence and uniqueness theorem for linear higher order initial value problems.
- Calculate the Wronskian of a list of functions and use it to determine if the functions are linearly independent.
- Verify that a two-parameter family of functions is a general solution to a nonhomogeneous differential equation.
- Construct a second solution to a differential equation from a given solution.

- Utilize the characteristic equation to determine the complimentary solution to a homogeneous linear differential equation with constant coefficients.
- Calculate the general solution to a homogeneous linear differential equation with constant coefficients.
- Solve a second order differential equation by the method of undetermined coefficients and variation of parameters.
- Apply the method of variation of parameters to solve linear non-homogeneous differential equations with variable coefficients.

Unit IV Differential Equations with Variable Coefficients and Applications [Supports Course SLO #6]

Learning Objectives

The student will be able to:

- Recognize and solve Cauchy-Euler differential equations.
- Apply power series techniques to solve differential equations around ordinary points and regular singular points.
- Integrate theory, skills and technology to solve problems involving harmonic oscillators, electric circuits, and other applications.

Unit V Laplace Transforms [Supports Course SLO #7]

Learning Objectives

The student will be able to:

- Define the Laplace transform.
- Calculate the Laplace transform and inverse transform of given functions.
- Apply the Laplace translation theorems and Laplace transforms of derivatives to solve *n*th order linear differential equations with constant coefficients and initial conditions.
- Apply appropriate methods to problems involving step functions, discontinuous forcing functions, and impulse functions and other applied problems.

Unit VI Systems of Linear Differential Equations [Supports Course SLOs #8]

Learning Objectives

The student will be able to:

- Construct the matrix form of a corresponding system of differential equations.
- Calculate solutions to systems of differential equations by the differential operator and Laplace transform methods.
- Calculate eigenvalues and eigenvectors of a matrix.
- Solve systems of differential equations using eigenvalues and eigenvectors and the method of variations of parameters.
- Describe the matrix exponential.

Evaluation of student learning:

Students will receive regular feedback on their work through graded assignments, examinations, and projects. The syllabus for this course should describe the schedule for these assessment tools and how they will be used to calculate grades. Learning activities will consist of a combination of lectures, graded assignments, demonstrations and examinations. The specific choices for assessment will rest with the instructor. Outside of class, students are expected to do a significant amount of work to achieve learning goals for this course. A typical grading scheme for this course follows:

Exams	50%
Graded Assignments, projects	20%
Final Exam (Cumulative)	30%