# Math 285: Differential Equations (3 credit hours)

## Course Description

This is an introduction to ordinary differential equations with an emphasis on applications. Topics for this course include first-order, linear higher-order, and systems of differential equations, numerical methods, series solutions, eigenvalues and eigenvectors, Laplace transforms, and Fourier series.

Prerequisite: Calculus III

## Course Objectives

After completing this course a successful student will be able to understand and apply the topics listed above. He/she will also be able to apply numerical, computational, and estimation techniques. Through exploration, a successful student will be able to use differential equations to model and analyze physical phenomena. He/she will also have the necessary tools to formulate and solve problems in mathematical situations and connect concepts to other disciplines. Most importantly, a student completing this course will be able to communicate ideas through descriptive language as well as mathematical symbols.

## Course Content and Format

*Content*

A brief outline of topics for this course appears below:

- Exponential differential equation
  - Forced vs. unforced exponential differential equations
  - Application to personal finances
- Forced oscillator differential equation
  - Underdamped and overdamped oscillators
  - Characteristic equations
  - Impulse and Ramp forced oscillators
- Laplace Transform and Fourier Analysis
  - Periodic functions and trigonometric series
  - General Fourier series and convergence
  - Creating formulas for forced exponential and oscillator diff. equations
  - Approximating periodically forced oscillators

- Modern differential equation issues
    - Euler's method of faking a solution plot
    - Sensitive dependence on starter data
- First order differential equations
    - Phase lines
    - Slope fields and solution curves
    - Reading bifurcation plots
    - Separation of variables
- Systems and Flows
    - Flow analysis
    - Interpreting vector fields
- Eigenvectors and Eigenvalues for Linear Systems
    - Generating solutions for linear systems
    - Eigenvalue trajectory analysis
    - Traces and determinants
- Linearizations
    - Finding equilibrium points
    - Lyapunov's rules
    - Linearizing the pendulum oscillator
- The Heat Equation and the Wave Equation
    - Fast Fourier fit
    - Fourier integral fit
    - Generating solutions with a list of starting conditions

*Format*

Course content is drawn from *Differential Equations* written by Bill Davis, Horacio Porta and Jerry Uhl ©2006-2010.

Math 285 utilizes the CAS-ILE system. *See https://cas-ile.illinois.edu/ for more information.* This online system helps students learn math topics through dynamic exploration and visualization.

Exams for Math 285 are taken online.