



## Math 286: Differential Equations Plus (4 credit hours)

### Course Description

This is an introduction to both ordinary and partial differential equations with an emphasis on advanced applications. Math 286 is intended for engineering students and others who require a working knowledge of differential equations. Topics for this course include first-order, linear higher-order, and systems of differential equations, numerical methods, series solutions, eigenvalues and eigenvectors, Laplace transforms, Fourier series, and matrix applications.

Prerequisite: Calculus III

### Course Objectives

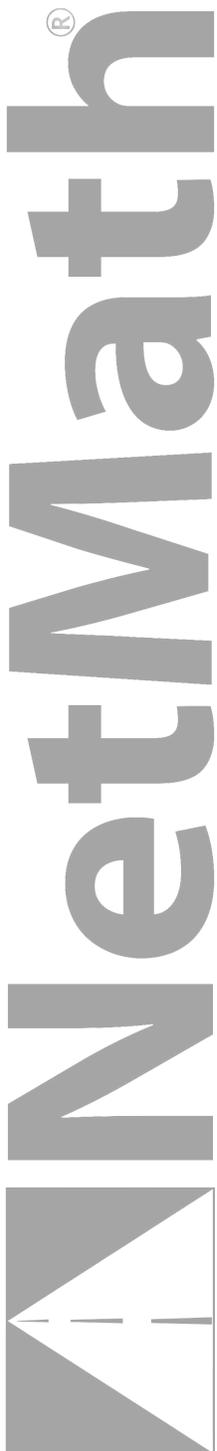
After completing this course a successful student will be able to understand and apply the topics listed above. He/she will also be able to apply numerical, computational, and estimation techniques. Through exploration, a successful student will be able to use differential equations to model and analyze 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
  - Linear system matrices
- 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 286 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 286 are taken with pencil and paper.

