

# Math 211

Lecture #1  
Introduction

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## Welcome to Math 211

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## Ordinary Differential Equations with Linear Algebra

There are four themes to the course:

- Applications & modeling.
  - ♦ Mechanics, electric circuits, population genetics  
epidemiology, pollution, pharmacology, personal  
finance, etc.
- Analytic solutions.
  - ♦ Solutions which are given by an explicit formula.

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- Numerical solutions.
  - ♦ Approximate solutions computed at a discrete set of points.
- Qualitative analysis.
  - ♦ Properties of solutions without knowing a formula for the solution.

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[Themes 1 & 2](#)

## Math 211 Web Pages

- Official source of information about the course.  
<http://www.owl.net.rice.edu/~math211/> .
- Source for the slides for section 1.  
<http://math.rice.edu/~polking/slidesf01.html> .

## What Is a Derivative?

- The rate of change of a function.
- The slope of the tangent line to the graph of a function.
- The best linear approximation to the function.
- The limit of difference quotients.
- Rules and tables that allow computation.

## What Is an Integral?

- The area under the graph of a function.
- An anti-derivative.
- Rules and tables for computing.

## Differential Equations

An equation involving an unknown function and one or more of its derivatives, in addition to the independent variable.

- Example:  $y' = \frac{dy}{dt} = 2ty$
- General equation:  $y' = \frac{dy}{dt} = f(t, y)$
- $t$  is the *independent variable*.
- $y = y(t)$  is the *unknown function*.
- $y' = 2ty$  is of *order 1*.

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## Solutions to Differential Equations

The general first order equation is

$$y' = f(t, y).$$

A *solution* is a function  $y(t)$ , defined for  $t$  in an interval, which is differentiable at each point and satisfies

$$y'(t) = f(t, y(t))$$

for every point  $t$  in the interval.

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### Example: $y' = 2ty$

Is  $y(t) = e^{t^2}$  a solution?

- By substitution  $y'(t) = 2ty(t)$ , so  $y(t) = e^{t^2}$  is a solution.

Is  $y(t) = e^t$  a solution?

- By substitution  $y'(t) \neq 2ty(t)$ , so  $y(t) = e^t$  is *not* a solution to the equation  $y' = 2ty$ .

Verification by substitution is always available.

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### More about Solutions

- A solution is a function. What is a function?
  - ♦ An exact, algebraic formula (e.g.,  $y(t) = e^{t^2}$ ).
  - ♦ A convergent power series.
  - ♦ The limit of a sequence of functions.
- An ODE is a function generator.
- Two of the themes of the course are aimed at those solutions for which there is no exact formula.

[Definition of solution](#)

[Definition of ODE](#)

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