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.

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

Math 211 Web Pages

- Official source of information about the course.
  http://www.owlnet.rice.edu/~math211/ .
- Source for the slides for section 2.
  http://math.rice.edu/~polking/slidesf03.html .
- Web CT home page http://webct.owlnet.rice.edu

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 Equation:

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

- Example: $y' = \dfrac{dy}{dt} = 2ty$
- General equation: $y' = \dfrac{dy}{dt} = f(t, y)$
- 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.

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.