

# Course Description

## D26: Differential Equations

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Professor of Mathematics

Time: MWF 1:00-2:00pm  
Location: Lunt 101

### 1. Introduction

This is a one-quarter introductory course on the theory of differential equations, with emphasis on the theory of partial differential equations. We plan to start with some interesting examples of partial differential equations and a brief review of the theory of ordinary differential equations. This is followed by a systematic introduction to the linear theory and the nonlinear theory of partial differential equations: the first order equations and the second order equations. Some important ideas and methods in this field will be presented. Canonical linear and nonlinear models, such as the wave equations, the transport equations, the Hamilton-Jacobi equations, the Hopf-Burgers equation, the Euler equations, and the Navier-Stokes equations will be analyzed in detail.

We will try to make this course self-contained. Familiarity with basic PDE theory is helpful, but not necessary. Advanced calculus and linear algebra are the only essential prerequisites.

Basic references are:

1. "Partial Differential Equations" by Lawrence C. Evans, Graduate Studies in Math. **19**, Amer. Math. Soc.: Providence, 1998.
2. "Partial Differential Equations" by Fritz John, 4th Edition, Springer-Verlag, New York, 1982.

## 2. Contents

### **Introduction**

#### **1. Ordinary Differential Equations**

Local existence and uniqueness for the Cauchy problem, Existence of solutions in the large, Generalized solutions

#### **2. Explicit Formulas for Solutions of Certain Linear PDEs**

Transport equation, Laplace's equation, Heat equation, Wave equation

#### **3. First-Order Nonlinear PDEs**

Complete integrals, Envelopes, Characteristics, Introduction to Hamilton-Jacobi equations, Introduction to conservation laws

#### **4. Other Various Ways to Represent Solutions of PDEs**

Separation of variables, Similarity solutions, Fourier transform, Converting nonlinear into linear PDEs, Asymptotics, Power series