# Introduction to Differential Equations

**Introduction**

An ordinary differential equation may be defined as an equation that involves a single unknown function of single variable and some finite number of its derivatives. For example, a simple problems from calculus is that of finding all functions f for which

$$f'(x) = 3x^2 - 4x + 5$$

For all x. Clearly a function f satisfies the condition (1.1) if and only if it is of the form

$$f(x) = x^3 - 2x^2 + 5x + c,$$

Where c is arbitrary number. A more difficult problem is that of finding all functions g for which

$$g'(x) + 2[g(x)]^2 = 3x^2 - 4x + 5.$$

Another difficult problem is that of finding all functions y for which (we use the abbreviation y for y(x))

$$x^2 \frac{d^2y}{dx^2} - 3x\left(\frac{dy}{dx}\right)^2 + 4y = \sin x.$$

In each of the problems (1.1), (1.2), and (1.3) we are asked to find all functions that satisfy a certain condition, where the condition involves one or more derivatives of the function. We can reformulate our definition of a differential equation as follows. Let F be a function of n + 2 variables. Then the equation

$$F\left[x, y, y', y'', \ldots, y^{(n)}\right] = 0$$

Is called an ordinary differential equation of order n for the unknown function y. The order of the equation is the order of the highest order derivative that appears in the equation. Thus, Eqs. (1.1) and (1.2) are first-order equations, while Eq. (1.3) is of second order.

A partial differential equation (as distinguished from an ordinary differential equation) is an equation that involves an unknown function of more than one independent variable, together with partial derivatives of the function. An example of a partial differential equation for an unknown function u(x,t) of two variables is

$$\frac{\partial^2 u}{\partial x} = \frac{\partial u}{\partial t} + u.$$

# Differential Equations An Introduction

Shepley L. Ross

**Differential Equations An Introduction:**

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