

Chapter 9

Differential Equations

Introduction to Differential Equations

An equation that involves an independent variable, dependent variable and differential coefficients of dependent variable with respect to the independent variable is called a **differential equation**.

e.g.,

$$(i) \quad x^2(d^2y / dx^2) + x^3 (dy / dx)^3 - 7x^2y^2$$

$$(ii) \quad (x^2 + y^2) dx = (x^2 - y^2) dy$$

Order and Degree of a Differential Equation

The order of a differential equation is the order of the highest derivative occurring in the equation. The order of a differential equation is always a positive integer.

The degree of a differential equation is the degree (exponent) of the derivative of the highest order in the equation, after the equation is free from negative and fractional powers of the derivatives.

Linear and Non-Linear Differential Equations

A differential equation is said to be linear, if the dependent variable and all of its derivatives occurring in the first power and there are no product of these. A linear equation of n th order can be written in the form

$$P_0 \frac{d^n y}{dx^n} + P_1 \frac{d^{n-1} y}{dx^{n-1}} + P_2 \frac{d^{n-2} y}{dx^{n-2}} + \dots + P_{n-1} \frac{dy}{dx} + P_n y = Q$$

where, $P_0, P_1, P_2, \dots, P_{n-1}$ and Q must be either constants or functions of x only.

A linear differential equation is always of the first degree but every differential equation of the first degree need not be linear.

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