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(a) A Differential equation is a relationship between an independent variable (x) and dependent variable (y) and one or more derivative of y with respect to x

Examples: (i) $dy/dx = 2 + y/x$

(ii) $dy/dx = y + y/x$

$y = Ae^{-4x} + Be^{-6x}$

(b) A second order differential equation

(c) A second order differential equation can be formed because it contains 2 constants in the degenerate equation

$y = Ae^{-4x} + Be^{-6x}$

Solution

$dy/dx = -4Ae^{-4x} - 6Be^{-6x}$ ---- (1)

$\frac{d^2y}{dx^2} = 16Ae^{-4x} + 36Be^{-6x}$ --- (2)

Solving equ (1) and (2) simultaneously

Multiply equ (1) by 6

$6\,dy/dx = -24Ae^{-4x} - 36Be^{-6x}$ --- (3)

$d^2y/dx^2 = +16Ae^{-4x} + 36Be^{-6x}$ --- (4)

$6\,dy/dx + d^2y/dx^2 = -8Ae^{-4x}$

$A = \dfrac{6\,dy/dx + d^2y/dx^2}{-8e^{-4x}}$ --- (5)

Substituting equ (5) into equ (4)

$$dy/dx = \frac{6\,dy/dx + d^2y/dx^2}{2} - 6Be^{-6x}$$

Multiply through by 2

$$2\,dy/dx = 6dy/dx + d^2y/dx^2 - 12Be^{-6x}$$

$$2\,dy/dx - 6\,dy/dx = d^2y/dx^2 - 12Be^{-6x}$$

$$-4\,dy/dx - d^2y/dx^2 = -12Be^{-6x}$$

$$\frac{-4\,dy/dx - d^2y/dx^2}{-12e^{-6x}} = B \quad \therefore \quad \frac{4\,dy/dx + d^2y/dx^2}{12e^{-6x}} =$$

Substitute A and B into the degenerate equation

$$\therefore y = \frac{6\,dy/dx + d^2y/dx^2 + e^{4x}}{-8e^{4x}} + \frac{4\,dy/dx + d^2y/dx^2 + e^{6x}}{12e^{6x}}$$

$$y = \frac{6\,dy/dx + d^2y/dx^2}{-8} + \frac{4\,dy/dx + d^2y/dx^2}{12}$$

$$y = \frac{-72\,dy/dx - 12\,d^2y/dx^2 + 32\,dy/dx + 8\,d^2y/dx^2}{96}$$

$$y = \frac{-40\,dy/dx - 4\,d^2y/dx^2}{96}$$