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17/ENG04/3/...
CIVIL ENGINEERING

1) ~~[illegible]~~ equation is the [illegible] [illegible] [illegible] and
have [illegible] [illegible]

2) A differential equation is the relationship between one independent variable y and 1 or more derivatives of y with respect to x.

E.g $xy\frac{d^2y}{dx^2} + \frac{dy}{dx} + e^{3x} = 0$

$x^2\frac{dy}{dx} = y \sin x = 0$

b) An expression has been obtained for an engineering system to be given in equation 1

$y = Ae^{-4x} + Be^{-3x}$

i) What is the order of the differential equation that can be formed from the ~~equation~~ expression

= Second order expression

ii) Given reason

= A function with no arbitrary constants gives a second order equation.

iii) Form the differential equation from the expression

$y = Ae^{4x} + 6Be^{-6x}$ (1)

$dy/dx = 4Ae^{-4x} + (6Be^{-6x}) = 4Ae^{-4x} - 6Be^{-6x}$ (2)

$\frac{d^2y}{dx^2} = 16Ae^{-4x} + 36Be^{-6x}$ (3)

From equation (2)

$\frac{dy}{dx} = -4Ae^{-4x} - 6Be^{-6x}$

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

$Ae^{-4x} = \left(\frac{dy}{dx} - 6Be^{-6x}\right)\frac{1}{4}$

$\therefore A = \left(\frac{dy}{dx} - 6Be^{-6x}\right)\frac{1}{4e^{-4x}}$

Put equation 4 into 3

$\frac{d^2y}{dx^2} = 16\left[\frac{dy}{dx} - 6Be^{-6x}\right]\frac{1}{4e^{-4x}} \times e^{-4x} + 36Be^{-6x}$

$\frac{d^2y}{dx^2} = 4\frac{dy}{dx} - 24Be^{-2x} + 36Be^{-6x}$

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

$B = \left[\frac{d^2y}{dx^2} + 4\frac{dy}{dx}\right]\frac{1}{12e^{-6x}}$ — (5)

Put eqn 5 into 4

$A = \left[\frac{dy}{dx} - 6\left[\frac{d^2y}{dx} + 4\frac{dy}{dx}\right]\frac{1}{12e^{-6x}} \times e^{-6x}\right]\frac{1}{4e^{-4x}}$

$A = -\left[-\frac{dy}{dx} - \frac{1}{2}\frac{d^2y}{dx^2} - 2\frac{dy}{dx}\right]\frac{1}{4e^{-4x}}$

$A = \left[3\frac{dy}{dx} - \frac{1}{2}\frac{d^2y}{dx^2}\right]\frac{1}{4e^{-4x}}$ (6)

Put eqn 5 and 6 into 1

$y = \left[-3\frac{dy}{dx} - \frac{1}{2}\frac{d^2y}{dx^2}\right]\frac{1}{4e^{-4x}} \times e^{-x} + \left[\frac{d^2y}{dx^2} + 4\frac{dy}{dx}\right]\cdot\frac{1}{12e^{-x}} \times e^{-2}$

$y = -\frac{3}{4}\frac{dy}{dx} - \frac{1}{8}\frac{d^2y}{dx^2} + \frac{1}{2}\frac{d^2y}{dx^2} + \frac{1}{3}\frac{dy}{dx}$

$y = \frac{5}{12}\frac{dy}{dx} - \frac{1}{24}\frac{d^2y}{dx^2}$

$y = \left[-5\frac{dy}{dx} - \frac{1}{2}\frac{d^2y}{dx^2}\right]\frac{1}{12}$