

IGHOPARD ALEXANDRA OSATO

SIENKOSOLO

MECHATRONICS

$$1. \frac{d^2y}{dx^2} + 4 \frac{dy}{dx} + 5y = 6 \sin \theta$$

$$\text{let } y'' + 4y' + 5y = 0$$

$$y = e^{kx} \quad y' = k e^{kx} \quad y'' = k^2 e^{kx}$$

$$k^2 e^{kx} + 4k e^{kx} + 5 e^{kx} = 0$$

$$e^{kx} (k^2 + 4k + 5) = 0$$

$$k = \frac{-4 \pm \sqrt{16 - 20}}{2}$$

$$= \frac{-4 \pm \sqrt{-4}}{2}$$

$$k = -2 \pm i$$

$$y_h = e^{-2x} (C_1 \cos x + C_2 \sin x)$$

$$y = A \cos \theta + B \sin \theta$$

$$y' = -A \sin \theta + B \cos \theta$$

$$y'' = -A \cos \theta - B \sin \theta$$

$$-A \cos \theta - B \sin \theta + 4(-A \sin \theta + B \cos \theta) + 5(A \cos \theta + B \sin \theta) = 6 \sin \theta$$

$$= -A \cos \theta - B \sin \theta + 4A \sin \theta + 4B \cos \theta + 5A \cos \theta + 5B \sin \theta$$

$$= 6 \sin \theta$$

$$\cos \theta (-A + 4B + 5A) + \sin \theta (-B + 4A + 5B) = 6 \sin \theta$$

$$4A + 4B = 0$$

$$4B - 4A = 6$$

$$8B = 6$$

$$B = \frac{3}{4}$$

$$4A + 4\left(\frac{3}{4}\right) = 0$$

$$A = -\frac{3}{4}$$

$$y_p = -\frac{3}{4} \cos \theta + \frac{3}{4} \sin \theta$$

$$y_s = e^{-2x} (C_1 \cos \theta + C_2 \sin \theta) = -\frac{3}{4} \cos \theta + \frac{3}{4} \sin \theta$$

$$y' = \frac{3}{4} \sin \theta + \frac{3}{4} \cos \theta = 0$$

$$\frac{3}{4} \sin \theta = -\frac{3}{4} \cos \theta$$

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$$2. \quad EI \frac{d^2 y}{dx^2} = \frac{\omega}{2} (L - x)^2$$

E, I, ω are constant

$$EI k^2 = 0$$

$$k^2 = 0$$

$$k = \pm \sqrt{0}$$

$$k = \pm 0$$

$$y = e^{2x} (A + Bx)$$

$$y = A + Bx$$

$$y_p = Fx^2 + Gx^3 + Hx^4$$

$$y' = 2Fx + 3Gx^2 + 4Hx^3$$

$$y'' = 2F + 6Gx + 12Hx^2$$

$$EI(2F + 6Gx + 12Hx^2) = \frac{\omega}{2} (L - x)^2$$

$$2FEI + 6GxIEI + 12Hx^2IEI = \frac{\omega}{2} (L - x)^2$$

$$4FEI + 12GxIEI + 24Hx^2IEI = \omega (L^2 - 2Lx + x^2)$$

$$24HEI = \omega$$

$$H = \frac{\omega}{24EI}$$

$$12GIEI = 2\omega L$$

$$G = \frac{2\omega L}{12EI} = \frac{-\omega}{6EI}$$

$$4FEI = \omega L^2$$

$$F = \frac{\omega L^2}{4EI} = \frac{-\omega}{6EI}$$

$$4FEI = \omega L^2$$

$$F = \frac{\omega L^2}{4EI}$$

$$y = \left[\frac{\omega L}{4EI} \right] x^2 - \left[\frac{\omega L}{6EI} \right] x^3 + \left[\frac{\omega}{24EI} \right] x^4$$

$$= \frac{\omega L^2}{4EI} x^2 - \frac{\omega L}{6EI} x^3 + \frac{\omega}{24EI} x^4$$

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$$A = 0$$

$$y' = B + \frac{w}{24EI} (12L^2x - 8Lx + 4x^3)$$

$$0 = B + \frac{w}{24EI} (12L^2(0) - 8L(0) + 4(0)^3)$$

$$B = 0$$

$$y = Fx^2 + Gx^3 + Hx^4$$

$$= \frac{wL^2x^2}{4EI} - \frac{wLx^3}{6EI} + \frac{wx^4}{24EI}$$

$$y = \frac{w}{24EI} (6L^2x^2 - 4Lx^3 + x^4)$$

$$y = \frac{wL^2}{24EI} (6L^2 - 4Lx + x^2)$$

$$\text{at } x = l$$
$$y = \frac{wL^2}{24EI} (6L^2 - 4L^2 + l^2)$$

$$y = \frac{3wL^2}{24EI}$$

$$y = \frac{wL^2}{8EI}$$