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 Chemical Engineering  
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 ENCA 381

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

$$\text{let } 6\sin\theta = 0$$

$$m^2 + 4m + 5 = 0$$

$$a = 1 \quad b = 4 \quad c = 5$$

$$m = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-4 \pm \sqrt{4^2 - 4 \times 1 \times 5}}{2 \times 1}$$

$$= \frac{-4 \pm \sqrt{-4}}{2} = \frac{-4 \pm j2}{2}$$

$$m = -2 \pm j$$

$$m = \alpha \pm j\beta$$

$$\text{C.F. } y = e^{-2x} (A \cos\theta + B \sin\theta)$$

$$f(x) = 6\sin\theta$$

$$\text{P.I. } y = C \cos\theta + D \sin\theta$$

$$\frac{dy}{d\theta} = -C \sin\theta + D \cos\theta$$

$$\frac{d^2y}{d\theta^2} = -C \cos\theta - D \sin\theta$$

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

$$C \cos\theta - D \sin\theta + 4(-C \sin\theta + D \cos\theta) + 5(C \cos\theta + D \sin\theta) = 6\sin\theta$$

$$-C \cos\theta - D \sin\theta - 4C \sin\theta + 4D \cos\theta + 5C \cos\theta + 5D \sin\theta = 6\sin\theta$$

$$4C \cos\theta + 4D \sin\theta - 4C \sin\theta + 4D \cos\theta = 6\sin\theta$$

$$4C \cos\theta + 4D \cos\theta + 4D \sin\theta - 4C \sin\theta = 6\sin\theta$$

$$(4C + 4D) \cos\theta + (4D - 4C) \sin\theta = 6\sin\theta$$

$$4C + 4D = 0 \quad \dots \text{ (i)}$$

$$-4C + 4D = 6 \quad \dots \text{ (ii)}$$

$$8D = 6$$

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

from equ (i)

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

$$4C + 3 = 0$$

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

$$P-I : y = -3/4 \cos \theta + 3/4 \sin \theta$$

$$C-F = C-I + P-I$$

$$y = e^{-2x} (A \cos \theta + B \sin \theta) - 3/4 \cos \theta + 3/4 \sin \theta$$

steady state eqn

$$y' = 3/4 \sin \theta + 3/4 \cos \theta = 0$$

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

$$\tan \theta = -1$$

$$\theta = \tan^{-1}(-1)$$

$$\theta = -45^\circ$$

$$2) EI \frac{d^2y}{dx^2} = w/2 (1-x)^2$$

$$EI m^2 = 0$$

$$m^2 = 0$$

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

$$m = \pm 0$$

$$y = e^{0x} (A + Bx)$$

$$C-I : y = A + Bx$$

$$P-I : y = fx^2 + Gx^3 + Hx^4$$

$$\frac{dy}{dx} = 2fx + 3Gx^2 + 4Hx^3$$

$$\frac{d^2y}{dx^2} = 2f + 6Gx + 12Hx^2$$

$$EI (2f + 6Gx + 12Hx^2) = w/2 (1-x)^2$$

$$2fEI + 6GxEI + 12HEIx^2 = w/2 (1-x)^2$$

$$4fEI + 12GxEI + 24HEIx^2 = w (1^2 - 2(1x) + x^2)$$

$$24HEI = w$$

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

comparing both equations

$$12GxEI = -2w(1-x)$$

$$G = \frac{-2w(1-x)}{12EI} = \frac{-w}{6EI}$$

$$4fEI = w(1-x)^2$$

$$f = \frac{w(1-x)^2}{4EI}$$

$$y = \left[ \frac{w(1-x)^2}{4EI} \right] x^2 - \left[ \frac{w(1-x)}{6EI} \right] x^3 + \left[ \frac{w}{24EI} \right] x^4$$

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

$$y = \frac{6wl^2 x^2}{24EI} - \frac{4wlx^3}{24EI} + \frac{wx^4}{24EI}$$

$$G.S = y = A + Bx + \frac{w}{24EI} [6l^2 x^2 - 4lx^3 + x^4]$$

at  $y=0$ ,  $x=0$  and  $\frac{dy}{dx} = 0$

$$0 = A + B(0) + \frac{w}{24EI} [6l^2(0)^2 - 4l(0)^3 + 0^4]$$

$$A = 0$$

$$\frac{dy}{dx} = B + \frac{w}{24EI} [12x^2l^2 - 12x^2l + 4x^3]$$

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

$$B = 0$$

$$y = Cx^2 + Dx^3 + Hx^4$$

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

$$y = \frac{w}{24EI} [6l^2 x^2 - 4lx^3 + x^4]$$

$$y = \frac{wx^2}{24EI} [6l^2 - 4lx + x^2]$$

when  $x = l$

$$y = \frac{wl^2}{24EI} [6l^2 - 4l^2 + l^2]$$

$$y = \frac{wl^2}{24EI} [3l^2]$$

$$y = \frac{3wl^4}{24EI}$$

$$y = \frac{wl^4}{8EI}$$