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16CK0201/023

CHEMICAL ENGINEERING

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

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

$m = -2 \pm j$.

$\alpha = -2 \qquad \beta = 1$

$y = e^{-2x}\{A\cos\theta + B\sin\theta\}$

Particular Integral $= C\cos\theta + D\sin\theta$

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

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

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

$\cos\theta(-C + 4D + 5C) = 0\cos\theta$

$4C + 4D = 0$.

$C = \frac{-4D}{4}$.

$C = -D$.

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

$4D - 4C = 6$.

$4D + 4D = 6$

$8D = 6$

$D = 6/8 = 3/4$.

$C = -3/4$.

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

General solution $\Rightarrow$

$y = e^{-2\theta}\{A\cos\theta + B\sin\theta\} - \frac{3}{4}\cos\theta + \frac{3}{4}\sin\theta$.

~~Nitting 9/10/1/AD~~

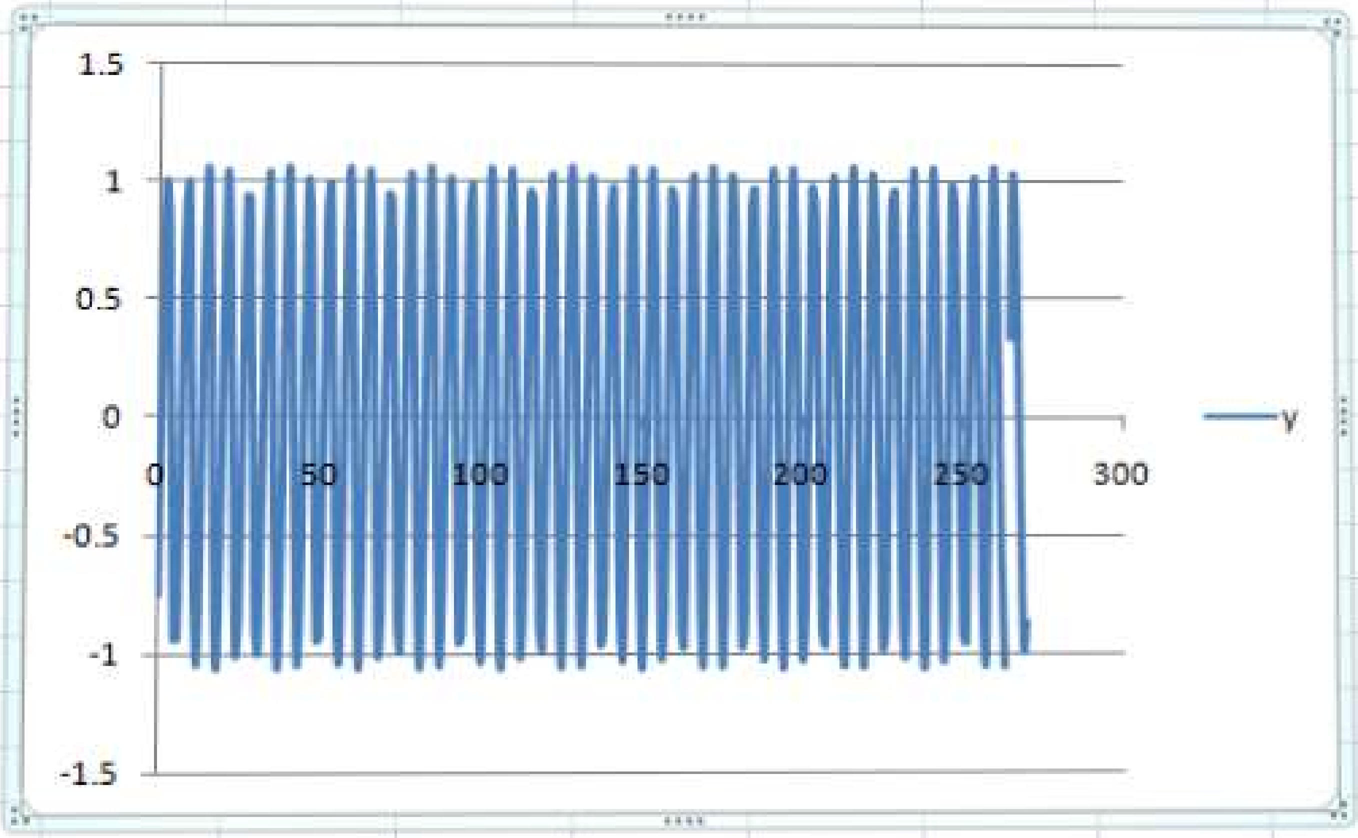
At steady state $\frac{d^2y}{d\theta^2} = 0$, $\theta = \infty$ and $e^{-\theta} = 0$

$\frac{dy}{dx} = e^{-2\theta}\{-A\sin\theta + B\cos\theta\} + \{A\cos\theta + B\sin\theta\} \cdot -2e^{-2\theta} + \frac{3}{4}\sin\theta + \frac{3}{4}\cos\theta$

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

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

$\frac{\sin\theta}{\cos\theta} = \frac{-3}{4} \times \frac{4}{3} = -1$.


1.5
1
0.5
0
-0.5
-1
-1.5
0
50
100
150
200
250
300
y

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CHEMICAL ENGINEERING

$\tan\theta = -1$

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

$= -45^\circ$

At steady state $\theta = -45^\circ$

(2)

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

$EIm^2 = 0$

$m = 0$

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

P.I:

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

$$\frac{dy}{dx} = 2Cx + 3Dx^2 + 4Ex^3$$

$$\frac{d^2y}{dx^2} = 2C + 6Dx + 12Ex^2$$

Sub in eqn (2).

$$EI(2C + 6Dx + 12Ex^2) = \frac{w}{2}(L-x)^2$$

$$EI(2C + 6Dx + 12Ex^2) = \frac{w}{2}(L^2 - 2xL + x^2).$$

$2CEI = \frac{w}{2}L^2$

$$C = \frac{wL^2}{4EI}$$

$6D\cancel{x}EI = -wL\cancel{x}$

$$D = \frac{-wL}{6EI}$$

$12E\,EI\,x^2 = \frac{w}{2}x^2$

$$E = \frac{w}{2} \times \frac{1}{12EI} = \frac{w}{24EI}$$

PI:

$$y = \frac{wL^2}{4EI}x^2 - \frac{wL}{6EI}x^3 + \frac{w}{24EI}x^4.$$

General solution

$$y = e^{0x}(A+Bx) + \frac{wL^2}{4EI}x^2 - \frac{wL}{6EI}x^3 + \frac{w}{24EI}x^4.$$

when $y = 0$ and $x = 0$

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$A = 0$

$$\frac{d^2y}{dx^2} = e^{0x} \cdot B + 0(A+Bx) \cdot + \frac{wL^2}{2EL}x + \frac{wL}{2EL}x^2 + \frac{w}{6EL}x^3$$

$$\frac{dy}{dx} = B + \frac{wL^2}{2EL}x + \frac{wL}{2EL}x^2 + \frac{w}{6EL}x^3$$

when $\frac{dy}{dx} = 0$ $x = 0$.

$0 = B$ $\therefore B = 0$.

$$y = \frac{wL^2}{4EL}x^2 - \frac{wL}{6EL}x^3 + \frac{w}{24EL}x^4.$$

when $x = L$

$$y = \frac{wL^4}{4EL} - \frac{wL^4}{6EL} + \frac{wL^4}{24EL}$$

$$y = \frac{6wL^4 - 4wL^4 + wL^4}{24EL}$$

$$y = \frac{3wL^4}{24EL}$$

$$y = \frac{wL^4}{8EL}$$