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Mechanical Engineering

EMG 381 Assignment

$$d^2x/dt^2 + 5dx/dt + 6x = \cos t$$

$$c.f \quad m^2 + 5m + 6 = 0$$

Using Completing the Square method

$$m + 5m \quad (-5/2)^2 = -6 + 25/4$$

$$(m + 5/2)^2 = 1/4$$

then root both sides

$$m + 5/2 = \pm 1/2$$

$$m = -3 \quad \text{or} \quad -2$$

$$A = c.f = Ae^{-3t} + Be^{-2t}$$

Particular Integral

$$A = C \cos t + D \sin t$$

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

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

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

$$5(C \cos t + 5D \cos t) = \cos t = \cos t \quad \text{--- eqn (1)}$$

$$-5(C \sin t + 5D \sin t) = 0$$

Simultaneous equations

$$5C + 5D = 1$$

$$-5C + 5D = 0$$

$$10D = 1$$

$$D = 1/10$$

$$P.I = x = -1/10 \cos t + 1/10 \sin t$$

$$x = Ae^{-3t} + Be^{-2t} + 1/10 (\sin t - \cos t)$$

When $t = 0$, $x = 0.1$ and $dy/dx = 0$

$$0.1 = A(1) + B(1) + 1/10 (-1)$$

$$0.1 = A + B - 0.1$$

$$A + B = 0.1 + 0.1$$

$$A + B = 0.2 \text{ --- eqn (3)}$$

$$dx/dt^2 = 3Ae^{-2t} - 2Be^{-2t} + 1/10 (\cos t + \sin t)$$

$$0 = -3A - 2B + 1/10(1)$$

$$-0.1 = 3A - 2B$$

$$3A + 2B = 0.1 \text{ --- eqn (4)}$$

thus,

$$A + B = 0.2$$

$$A = 0.2 - B \text{ eqn (5)}$$

Sub eqn (5) into eqn (4)

$$3(0.2 - B) + 2B = 0.1$$

$$0.6 - 3B + 2B = 0.1$$

$$-B = -0.5$$

$$B = 0.5$$

~~$$A = 0.2$$~~

~~$$A = 0.2$$~~
$$A = -0.3$$

therefore,

$$x = -0.3e^{-3t} + 0.1e^{-2t} + 1/10 (\sin t - \cos t)$$

$$= 0.1e^{-2t} - 0.3e^{-3t} + 1/10 (\sin t - \cos t)$$

Command Window

close all;

clear all;

clc;

Sym x, t

t = (0:0.1:15);

x = 0.1^4 * exp(-2*t) - 0.3 * exp(-3*t) + 0.1 * (sin(t) - cos(t))

plot (t,x)

$$(1c) \quad x = k \sin(t + a)$$

knowing $x = 0.1$ at $t = 0$ and $dx/dt = 0$

$$dx/dt = k \cos(t + a)$$

$$0 = k \cos(0 + a)$$

$$~~k \cos(a) = 0~~$$

$$0.1 = k \sin(0 + a) \quad \text{--- eqn (1)}$$

$$k \sin(a) = 0.1$$

$$\cos(a) = 0 \Rightarrow a = \cos^{-1}(0)$$

$$a = 90^\circ$$

sub a into eqn (1)

$$0.1 = k \sin(90)$$

$$k = 0.1 / \sin 90$$

$$k = 0.1$$

$$x = 0.1 (\sin(t + 90))$$

Command Window

Close all

clear all

clc

Sym + x

t = [0:0.1:15];

x = 0.1 * t.^k (sin(t + 90));

Plot(t, x)