DAN OTIENO - MIDTERM -03/06/23

① 14-bit accelerometer: $X = 10429$; $Y = 6626$.
$\pm 3g$.

Sensitivity: $1g \rightarrow (2^{14} - 1) / 6g$
$S = 2730$ (count/g).

$A_0 (0g) = 2^{13} = 8192$
$A_x = (X - A_0)/S = 0.8194$
$A_y = (Y - A_0)/S = -0.5736$

$\alpha = \tan^{-1} (A_y / A_x)$
$= \tan^{-1} (-0.5736 / 0.8194)$
$= \boxed{-34.993}$

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② Completed in Matlab.

③ $\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} + 10\,y(t) = \frac{dx(t)}{dt}$

$s^2 Y(s) - 1 + 2sY(s) + 10Y(s) = 1$

$Y(s)(s^2 + 2s + 10) = 2$

$Y(s) = \frac{2}{s^2 + 2s + 10} = \frac{2}{(s+1)^2 + 9}$

$\therefore \quad y(t) = \mathcal{L}^{-1}\left(\frac{2}{3} \cdot \frac{3}{(s+1)^2 + 9}\right)$

$= \frac{2}{3} e^{-t} \sin(3t)\, u t.$

Steady state response $= \boxed{0}$

transient response: $\boxed{y_{tr} = \frac{2}{3} e^{-t} \sin(3t)\, u t.}$

at $t = 1.4\,s$:

$y(1.4) = \frac{2}{3} e^{-1.4} \sin(3 \times 1.4)$

$= \boxed{-0.143}$

④ $\dfrac{3s+4}{s^2+2s+4}$

$$X(s) = \frac{3s+4}{s^2+2s+4} = \frac{3s+4}{(s+1)^2+3}$$

$$= \frac{3(s+1)+1}{(s+1)^2+3}$$

$$= 3\,\frac{(s+1)}{(s+1)^2+3} + \frac{1}{\sqrt{3}}\,\frac{\sqrt{3}}{(s+1)^2+3}$$

So:

$$x(t) = 3\cdot e^{-t}\cos(\sqrt{3}\,t)\,u t + \frac{1}{\sqrt{3}}\,e^{-t}\sin(\sqrt{3}\,t)\,u t$$

$$x(1) = 3e^{-1}\cos(\sqrt{3}\cdot 1) + \frac{1}{\sqrt{3}}\,e^{-1}\sin(\sqrt{3}\cdot 1)$$

$$= \boxed{0.032}$$

Console window Calculations. (MATLAB).

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>> otieno_midterm
Value of h(tau-t) at t = 1.4s: 0.522
>> (2/3)*exp(-1.4)*sin(3*1.4)

ans =

   -0.1433

>> 3*exp(-1)*cos(sqrt(3))+(1/sqrt(3))*exp(-1)*sin(sqrt(3))

ans =

    0.0324

>>
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