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ELEā / ELECT

SYSTEM RESPONSE 1

5) i $G(s) = \dfrac{2}{0.2s + 0.5}$ ——— (2)

from the ~~transfer function~~ Equation $= \boxed{\dfrac{K}{Ts + 1}}$ ——— 1

$$G(s) = \frac{2}{0.2s + 0.5} = \frac{2/0.5}{\frac{0.2s}{0.5} + \frac{0.5}{0.5}} = \frac{4}{0.4s + 1}$$

$$G(s) = \frac{4}{0.4s + 1}$$

from the equation 1, we have

$$\frac{4}{0.4s + 1} = \frac{K}{Ts + 1}$$

$\boxed{(K)\ \text{DC gain} = 4}$, $\boxed{\text{Time constant } (T) = 0.4}$

ii) $G(s) = \dfrac{0.2}{0.05s + 0.1}$

$$\frac{\frac{0.2}{0.1}}{\frac{0.05s}{0.1} + \frac{0.1}{0.1}} = \frac{2}{0.5s + 1}$$

from equation 1 we have $\boxed{K = 2}$, $\boxed{T = 0.5}$

iii) $G(s) = \dfrac{2}{3s+1}$

The transfer function is already in order, so

$\boxed{T = 3}$, $\boxed{K = 2}$

iv) $G(s) = \dfrac{16}{8s+4}$

$G(s) = \dfrac{16/4}{8/4\, s + 4/4} = \dfrac{4}{2s+1}$

$\boxed{T = 2}$, $\boxed{K = 4}$

Question 4

$G(s) = \dfrac{1}{3s+1} = \dfrac{1}{Ts+1}$

$\dfrac{x(s)}{F(s)} = \dfrac{1}{Ts+1}$

$x(s) = \dfrac{F(s)}{Ts+1}$, The input is a ramp so ramp input $= \dfrac{c}{s^2}$

$x(s) = \dfrac{c}{s^2(Ts+1)}$

$\dfrac{c/T}{s^2(s+1/T)}$

$\left(\dfrac{Ka}{s^2(s+a)}\right)$ - frequency domain

$K\left(t - T\left(1 - e^{-\frac{t}{T}}\right)\right)$ - Time domain

$$x(t) = C\left(t - T\left(1 - e^{-\frac{t}{T}}\right)\right)$$

$$= C\left(t - T(1)\right)$$, $\boxed{\text{for steady state error we will asume } (e^{-t/T}) \text{ to be small}}$

$$= C(t - T)$$

$$= Ct - CT$$

from $\theta_e = \theta_i - \theta_o$

$$\theta_e = C \cdot t - (Ct - CT)$$

$$\theta_e = CT$$

$$\theta_e = Ct = 4 \times 3 = 12\,mm$$ //

~~ii) $x(t) = 4(2 - 3(1 - 0.51))$~~

~~$= 4(2 - 3(0.49))$~~

ii) $x(t) = Ct - \left(CT\left(1 - e^{-t/T}\right)\right)$

$$= 4 \times 2 - \left(4 \times 3\left(1 - e^{-\frac{2}{3}}\right)\right)$$

$$= 8 - \left(12\left(1 - 0.5\right)\right)$$

$$= \cancel{4(0.49)} \quad 8 - 5.84$$

steady state error $= 2.161\,mm$. //

Queston 6

$$\frac{\omega}{\theta}(s) = \frac{K_m}{T_m s + 2} \quad \text{where} \quad K_m = 15\,s^{-1}, \; T_m = 4s$$

$$\frac{\omega(s)}{\theta} = \frac{15s^{-1}}{4s + 2} \quad \vdots \quad \frac{15/2}{4/2\,s + 2/2} = \frac{7.5}{2s + 1}$$

$\boxed{K = 7.5}$ $\boxed{T = 2\,seconds}$

1) From Diagram 1, we can deduce that

$$F(t) = Kx + B\frac{dx}{dt}$$

$$= \cancel{0.03x + 4}$$

$$= 0.03\frac{dx}{dt} + 4000x$$

$$F(s) = 0.03(s) + 4000x$$

$$F(s) = x(0.03s + 4000)$$

$$\frac{x(s)}{F(s)} = \frac{1}{0.03s + 4000}$$

$$\frac{x(s)}{F(s)} = \frac{1/4000}{\frac{0.03s}{4000} + \frac{4000}{4000}} = \boxed{\frac{2.5\times10^{-4}}{(s)7.5\times10^{-6} + 1}}$$

Transfer function

$$\frac{x(s)}{F(s)} = \frac{F(s)(2.5\times10^{-4})}{7.5\times10^{-6}s + 1}$$

$\boxed{\text{input } H/s}$

$$= \frac{H(2.5\times10^{-4})}{s(7.5\times10^{-6}s + 1)}$$

$$\frac{Ka}{s(s+a)} = K\left[1 - e^{-t/\tau}\right]$$

$$= \frac{\frac{H(2.5\times10^{-4}) \div \cancel{7.5}\times10}{7.5\times10^{-6}}}{s\left(\frac{\cancel{7.5\times10^{-6}}}{\cancel{7.5\times10^{-6}}} + \frac{1}{7.5\times10^{-6}}\right)} = \frac{H(3.33\times10^{-4})}{s(s + \cancel{133333.3}\ 1.3\times10^{-7})}$$

$$= \frac{\frac{H(2.5\times10^{-4})}{7.5\times10^{-6}}}{s(s + (1.3\times10^{-7}))} \text{ ——— } M$$

from equation (M) and from $\boxed{\dfrac{K/T}{s(s + 1/T)}}$ — (Y)

$\therefore$ $\boxed{t = T = 7.5\,\mu s}$

from equ Y, ~~th~~ $K\left(1 - e^{-t/T}\right)$

$K = 100 \times 2.5 \times 10^{-4} = 4 \times 10^{-3}$

$= 4 \times 10^{-3}\left(1 - e^{-T/T}\right)$

$= 4 \times 10^{-3}\,(0.63)$

$= 2.52 \times 10^{-3}$

System Response 2

2) $\frac{X_o}{X_i}(s) = \frac{1}{T^2 s^2 + 2\delta T s + 1}$

$\frac{X_o}{X_i}(j\omega) = \frac{1}{T^2 (j\omega)^2 + 2\delta T j\omega + 1}$

$\frac{X_o}{X_i}(j\omega) = \frac{1}{(1 - T^2\omega^2) + 2T\delta j\omega}$ (Now $j^2 = -1$)

$\frac{X_o}{X_i}(j\omega) = \frac{1}{A + jB}$

where $\boxed{A = (1 - T^2\omega^2)}$, $\boxed{B = 2T\delta\omega}$

$\frac{X_o}{X_i}(j\omega) = \frac{1 \times A - jB}{(A+jB)(A-jB)} = \frac{A - jB}{A^2 + jBA - jBA - jB^2}$

$= \frac{A - jB}{A^2 + B^2} \longrightarrow (X)$

from equ (X)

$C = \frac{A}{A^2 + B^2} = \frac{(1 - \omega^2 T^2)}{(1 - \omega^2 T^2)^2 + (2\delta\omega T)^2}$

$D = \frac{B}{A^2 + B^2} = \frac{2\delta T\omega}{(1 - T^2\omega^2)^2 + (2\delta\omega T)^2}$

solving for A & B

$A = 1 - T^2\omega^2$

$= 1 - (0.4^2 \times 2.5^2)$

$A = 0$

$B = 2T\delta\omega$

$B = 2 \times 0.4 \times 0.2 \times 2.5$

$B = 0.4$

$$C = \frac{0}{0 + 0.16} = 0$$

$$D = \frac{0.4}{0.16} = 2.5$$

$$\boxed{\begin{aligned}\phi &= -\tan^{-1}\left(\frac{2.5}{0}\right)\\ &= -\tan^{-1}(\infty)\\ &= -90^\circ\end{aligned}}$$

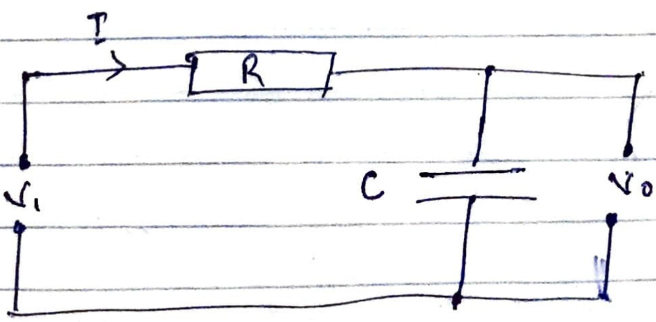
$R = \sqrt{C^2 + D^2} = \sqrt{D^2} = \sqrt{2.5^2}$

$R = 2.5$

$\boxed{\text{Amplitude} = 2.5 \times 6 = 15}$

~~The output equation : $\theta_o = 15 \sin(\omega t)$~~

1)



$$\frac{V_o}{V_i}(s) = 1/(Ts+1)$$

$$\frac{V_o}{V_i}(j\omega) = \frac{1}{j\omega T + 1}$$

$$\frac{V_o}{V_{in}} = \frac{1-j\omega T}{(1+j\omega T)(1-j\omega T)} = \frac{(1-j\omega T)}{1-\omega^2 T^2}$$

j is cancelled ~~been~~ when $j^2 = -1$

$$= \frac{1}{1-\omega^2 T^2} - \frac{j\,\omega T}{1-\omega^2 T^2}$$

$$\frac{V_o}{V_{in}}(j\omega) = A - jB, \quad \boxed{A = \frac{1}{1+\omega^2 T^2}}, \quad \boxed{B = \frac{\omega T}{1+\omega^2 T^2}}$$

$$A = \frac{1}{1+(2000 \times 9.4 \times 10^{-4})^2}$$

Note: $T = RC = 47 \times 20\,\mu F$

~~$T = 9.4 \times 10^{-3}$~~

$T = 9.4 \times 10^{-4}$

$$\boxed{A = 0.22}$$

$$B = \frac{2000 \times 9.4 \times 10^{-4}}{1+(2000 \times 9.4 \times 10^{-4})^2} = \frac{1.88}{4.53}$$

$B = 0.41$

$$\theta = -\tan^{-1}\left(\frac{B}{A}\right)$$

$$= -\tan^{-1}\left(\frac{0.41}{0.22}\right)$$

$$\theta = -61.78°$$

$$R = \sqrt{A^2 + B^2} = \sqrt{0.22^2 + 0.41^2} = \sqrt{0.048 + 0.168}$$

$R = 0.465$

Amplitude $= 5 \times 0.465 = 2.33$

From ①. V_{in} equation = $5\sin(2000t)$

$V_{out} = 2.33\sin(2000t - 61.78^\circ)$