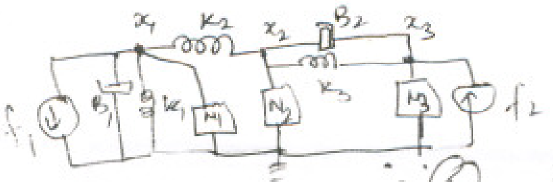
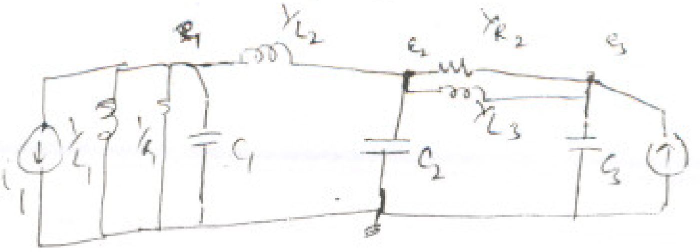
AAOC C321 Control System solution of Test 1 held on 28/09/10

(1)
$$M_1\ddot{x}_1 + B_1\dot{x}_1 + K_1x_1 + K_2(x_1 - x_2) + f_1 = 0$$
$$M_2\ddot{x}_2 + K_2(x_2 - x_1) + K_3(x_2 - x_3) + B_2(\dot{x}_2 - \dot{x}_3) = 0$$
$$M_3\ddot{x}_3 + K_3(x_3 - x_2) + B_2(\dot{x}_3 - \dot{x}_2) = f_2$$

$2 \times 3 = 6$



(3)



(4)

(2) $\frac{Y_1}{X_1}$ & $\frac{Y_2}{X_1}$ Two Possible TF

For $\frac{Y_1}{X_1} \Rightarrow$ two forward paths: $P_1 = G_1G_2G_3G_4$; $\Delta_1 = 1$
$P_2 = G_1G_5$; $\Delta_2 = 1 + G_3H_2$ (2)

4-loops: $L_1 = -G_1H_1$; $L_2 = -G_3H_2$; $L_3 = -G_1G_2G_3H_3$; $L_4 = -H_4$ (2)

Non touching loops two taken at a time: L_1L_2 ; L_1L_4 ; L_2L_4 ; L_3L_4 (2)

" " three " " " : $L_1L_2L_4$.

$$\Delta = 1 - (L_1 + L_2 + L_3 + L_4) + (L_1L_2 + L_1L_4 + L_2L_4 + L_3L_4) - L_1L_2L_4$$

$$\frac{Y_1}{X_1} = \frac{G_1G_2G_3G_4 + G_1G_5(1 + G_3H_2)}{1 + G_1H_1 + G_3H_2 + G_1G_2G_3H_3 + H_4 + G_1G_3H_1H_2 + G_1H_1H_4 + G_3H_2H_4 + G_1G_2G_3H_3H_4 + G_1G_3H_1H_2H_4}$$ (4)

For $\frac{Y_2}{X_1} \Rightarrow \Delta$ remains same; $P_1 = G_1G_2G_3$ $\Delta_1 = (1 + H_4)$ (2)

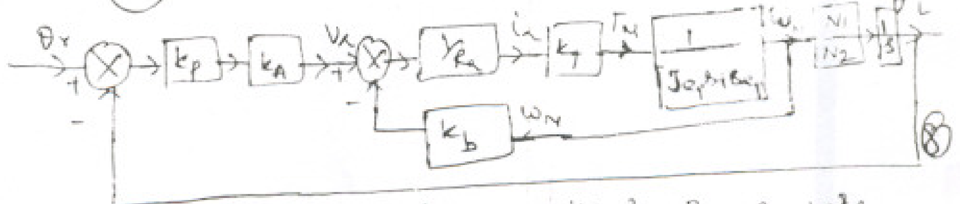
$$\frac{Y_2}{X_1} = \frac{G_1G_2G_3(1 + H_4)}{\Delta}$$ (3)

(3)

	A	B	C	D
CCW	1	0	0	1
	1	0	1	0
	0	1	1	0
	0	1	0	1
repeat	1	0	0	1

CW (10)

(4)



(8)

$J_{eq}: J_m + a^2 J_L = 0.2 + (\frac{1}{10})^2 \times 10 = 0.3\ kg\,m^2$; $B_{eq}: B_M + a^2 B_L = .01$ Nm/rad/sec (2)

Putting the value of parameters we get

$$T.F = \frac{\theta_L(s)}{\theta_r(s)} = \frac{5}{0.3s^2 + 1.01s + 5}$$ (6)

$$\theta_r(s) = \frac{5\pi}{180\,s} \Rightarrow \theta_L(t) = \lim_{s\to 0} s\,\theta_r(s) \times T.F. \Rightarrow \lim_{s\to 0} s \times \frac{5\pi}{180 s} \cdot \frac{5}{0.3s^2 + 1.01s + 5}$$

$= 5\pi/180$ rad (4)

$= .0873$ rad