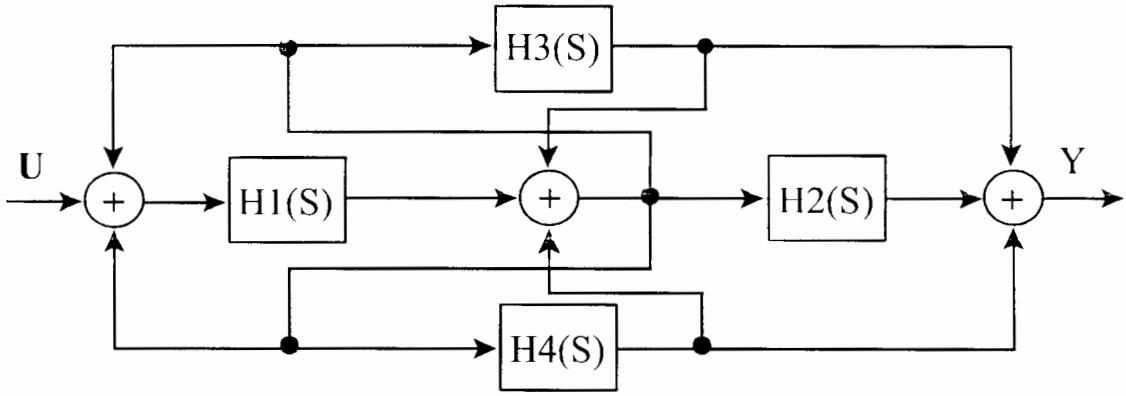
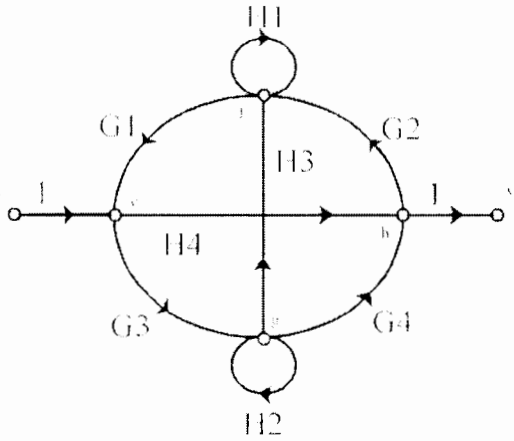
# EE 380- 1 Control Engineering I, Major-1

Wednesday, November 7th, 2007, 6:00 PM - 7:30 PM Dr. Ahmad A. Masoud

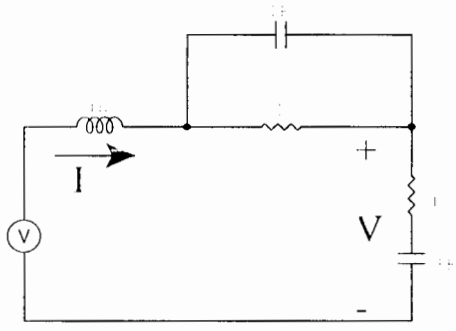



Q1 (5 marks): Use the block diagram reduction technique to compute the transfer function of the above system.

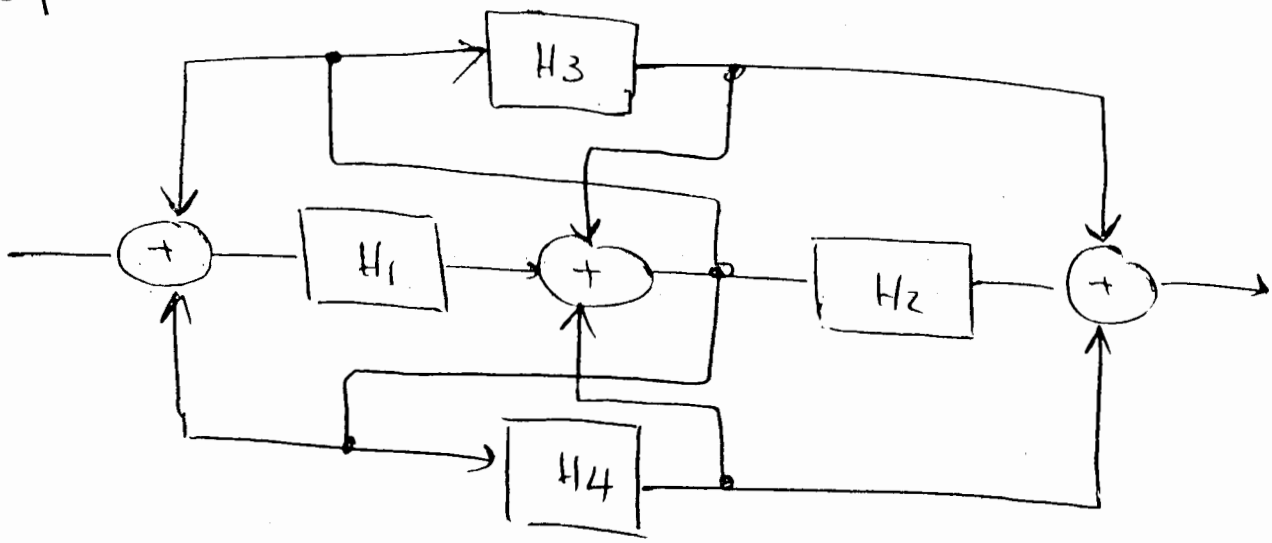
Q2 (5 marks)Use the signal flow graph (SFG) method to find the transfer function y/x.

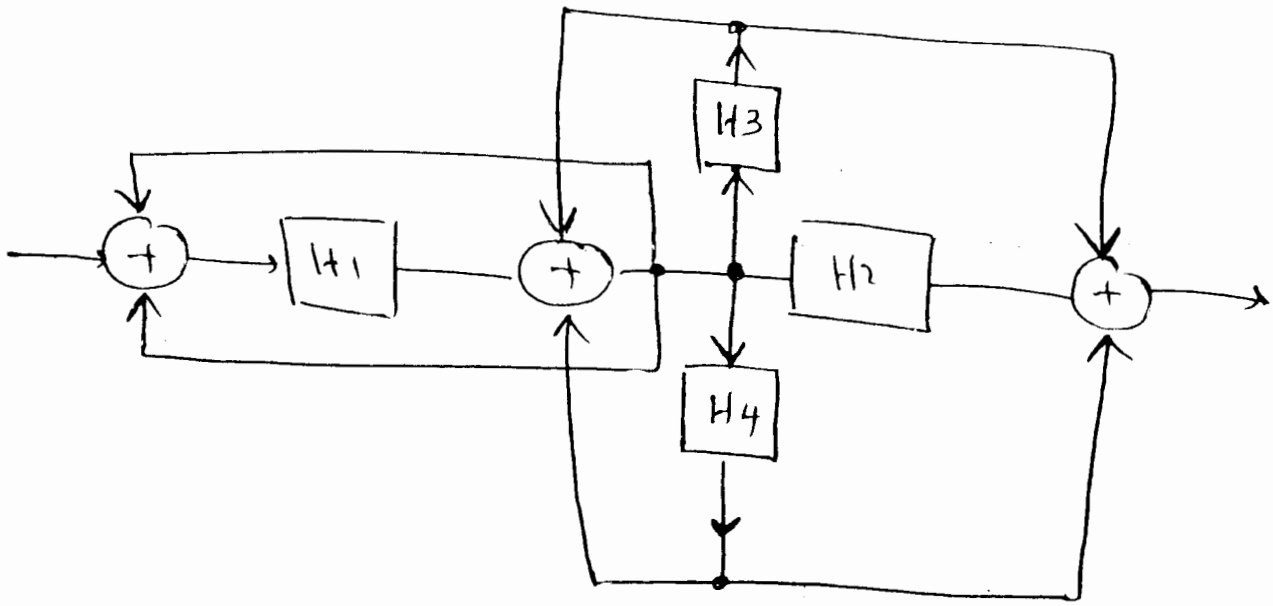


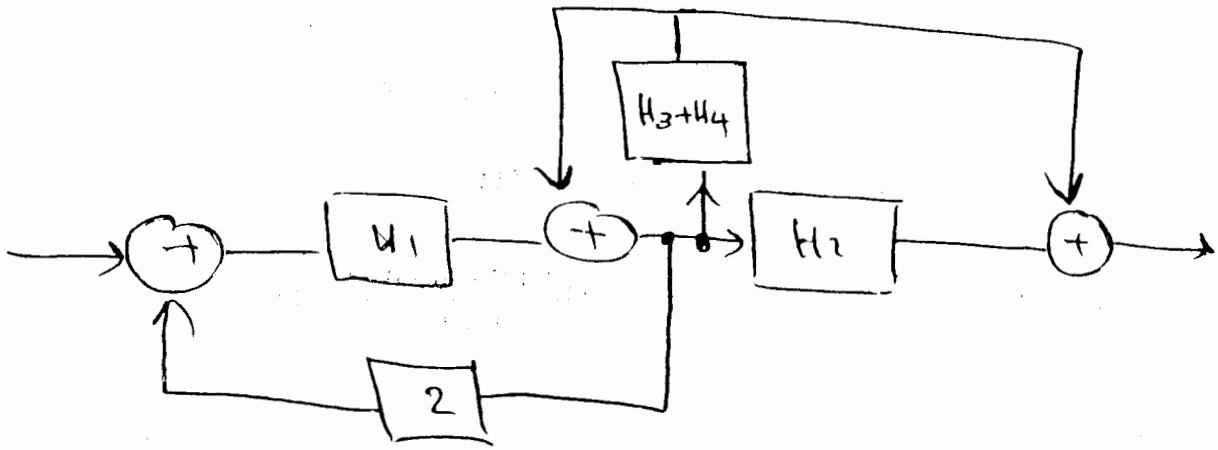

Q3 (5 marks): : Consider the circuit below. Let Vi be the input and V be selected as output. Write the state space equations of the circuit

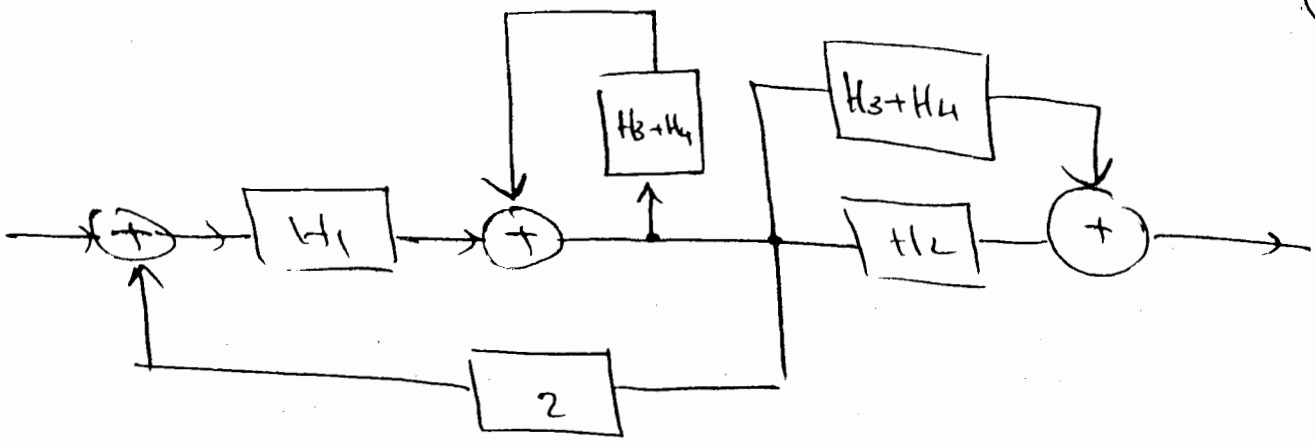


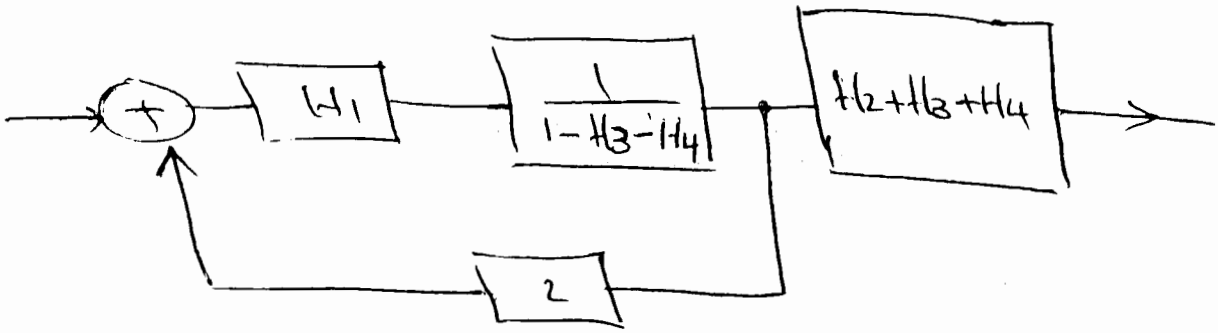
Q1

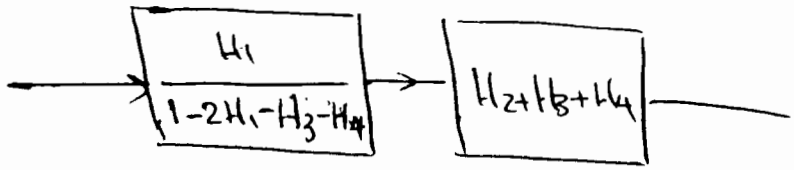


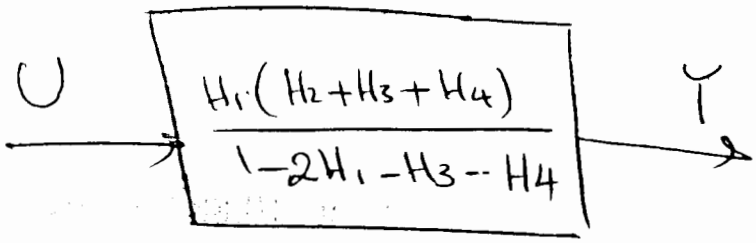



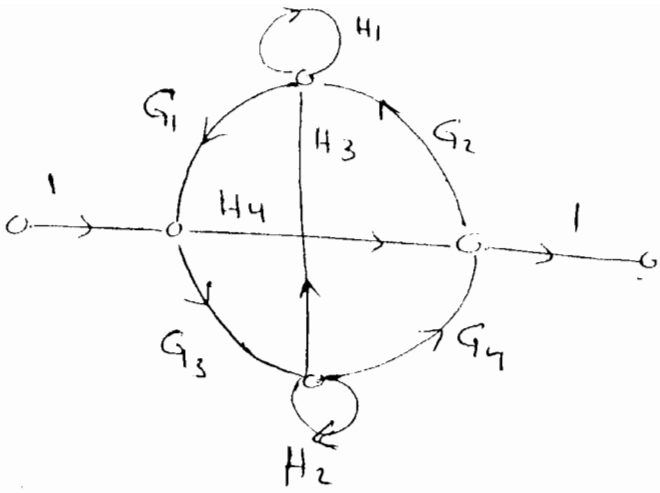

+
H1
+
H3+H4
H3+H4
H2
+
2


+
H1
1
1-H3-H4
H2+H3+H4
2

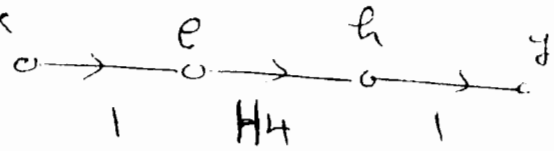

H1
1-2H1-H3-H4
H2+H3+H4


U
H1(H2+H3+H4)
1-2H1-H3--H4
Y

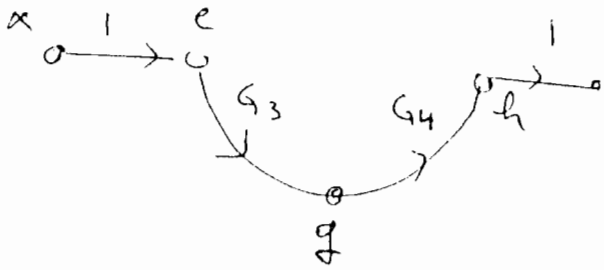
$Q_2$




Paths: x → e → h → y

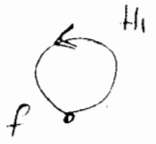



$\Rightarrow H_{L1}$

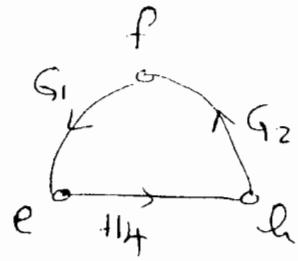


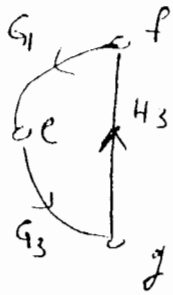

$\Rightarrow G_3 G_4$

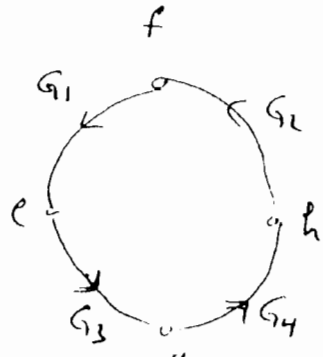
Loops








$L_1 = H_1 \quad L_2 = H_2 \quad L_3 = G_1 G_2 H_4 \quad L_4 = G_1 G_3 H_3$

$L_5 = G_1 G_2 G_3 G_4$

$L_1 L_2 \,,\, L_2 L_3$

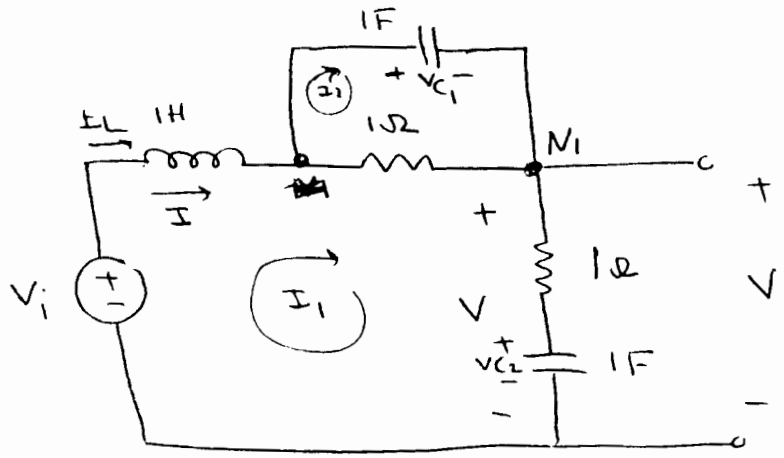
$$\therefore \Delta = 1 - [H_1 + H_2 + G_1 G_2 H_4 + G_1 G_3 H_3 + G_1 G_2 G_3 G_4 + H_1 H_2 + G_1 G_2 H_2 H_4 + H_1 H_2 + H_2 H_{L1} G_1 G_{12}]$$

$$\Delta_1 = 1 - H_1 - H_2 + H_1 H_2$$

$$\Delta_2 = 1 - H_1$$

$$\frac{Y}{X} = \frac{H_4 (1 - H_1 - H_2 + H_1 H_2) + G_3 G_4 (1 - H_1)}{1 - H_1 - H_2 - G_1 G_2 H_4 - G_1 G_3 H_3 - G_1 G_2 G_3 G_4 - H_1 H_2 - G_1 G_4 H_2 H_4 + H_1 H_2 + H_2 H_4 G_1 G_4}$$

Q3




(1)

at loop-1 :

$$-V_i + \frac{dI_L}{dt} + V_{C_1} + \frac{dv_{C_2}}{dt} + V_{C_2} = 0 \quad \text{——— (A)}$$

at loop-2 :

$$V_{C_1} + \left(\frac{dv_{C_1}}{dt} - I_L\right) = 0 \quad \text{——— (B)}$$

at node-1 :

$$V_{C_1} + \frac{dV_{C_1}}{dt} - \frac{dV_{C_2}}{dt} = 0 \quad \text{——— (C)}$$

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* $\frac{dV_{C_1}}{dt} = I_L - V_{C_1}$ ——— (1)

* (B) − (C) :

$$\frac{dV_{C_2}}{dt} = I_L \quad \text{——— (2)}$$

* (A) − (2)

$$\frac{dI_L}{dt} = -I_L - V_{C_1} - V_{C_2} + V_i \quad \text{——— (3)}$$

$$\begin{bmatrix} \dot{I}_L \\ \dot{V}_{C_1} \\ \dot{V}_{C_2} \end{bmatrix} = \begin{bmatrix} -1 & -1 & -1 \\ 1 & -1 & 0 \\ 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} I_L \\ V_{C_1} \\ V_{C_2} \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} V_i$$

← State Equation

* $I = I_L$

* $V = I_L + V_{C_2}$

$$\therefore \begin{bmatrix} V \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1 \end{bmatrix} \begin{bmatrix} I_L \\ V_{C_1} \\ V_{C_2} \end{bmatrix} + \begin{bmatrix} 0 \end{bmatrix} V_i$$

← output equation