Q5 question

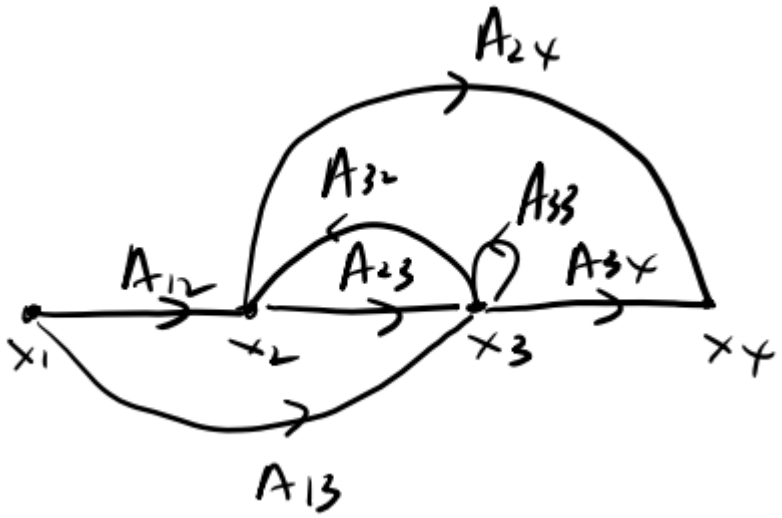
Construct the signal flow graph for the following set of simultaneous equations.

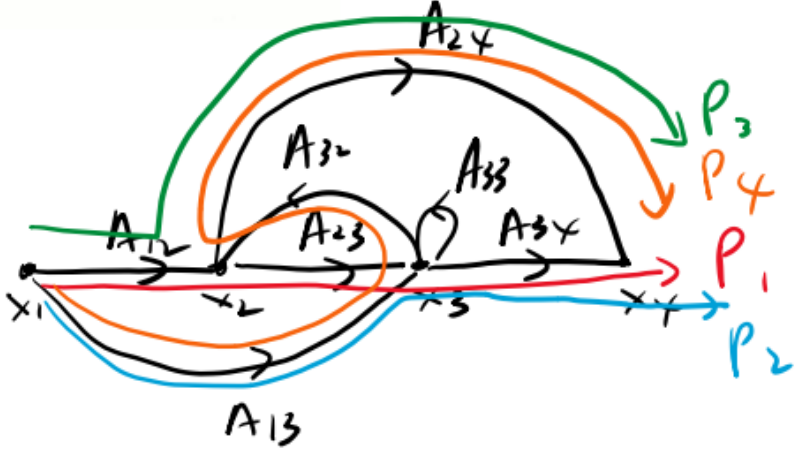
$$x_2 = A_{12}x_1 + A_{32}x_3$$
$$x_3 = A_{13}x_1 + A_{23}x_2 + A_{33}x_3$$
$$x_4 = A_{24}x_2 + A_{34}x_3$$

Hence determine the transfer function (x_4/x_1) using the Mason's rule.

Ans: $$\frac{x_4}{x_1} = \frac{A_{21}A_{42}(1 - A_{33}) + A_{23}A_{31}A_{42} + A_{31}A_{43} + A_{21}A_{32}A_{43}}{1 - A_{23}A_{32} - A_{33}}$$

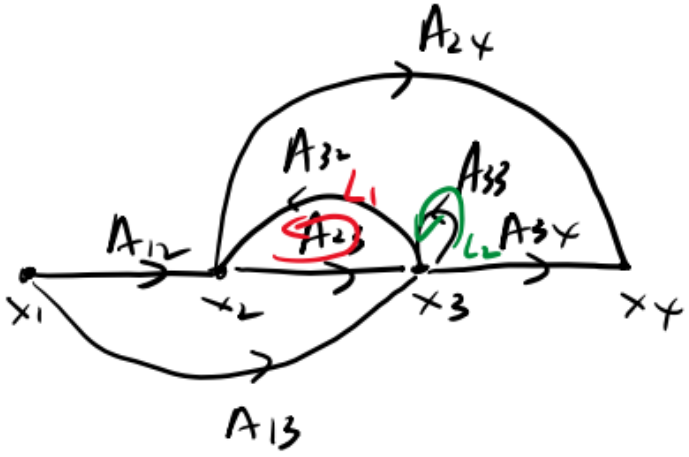
Q5 solution





Forward path:

$$P_1 = A_{21}A_{32}A_{43} \quad P_2 = A_{31}A_{43} \quad P_3 = A_{21}A_{42} \quad P_4 = A_{31}A_{23}A_{42}$$



Loop:

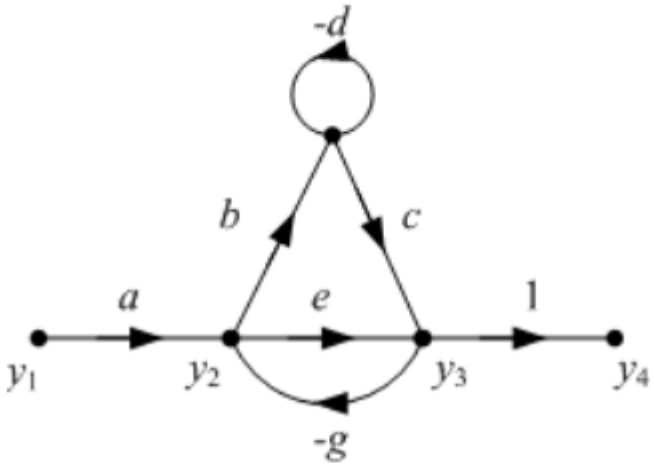
$$L_1 = A_{32}A_{23} \quad L_2 = A_{33}$$

Hence,

$$\frac{x_4}{x_1} = \frac{P_1\Delta_1 + P_2\Delta_2 + P_3\Delta_3 + P_4\Delta_4}{\Delta} = \frac{A_{21}A_{32}A_{43} + A_{31}A_{43} + (A_{21}A_{42})(1 - A_{33}) + A_{31}A_{23}A_{42}}{1 - A_{32}A_{23} - A_{33}}$$

Q6 question

Consider the signal flow graph below:



Hence determine the transfer function (y_4/y_1) using the Mason's rule.

Ans: $\frac{y_4}{y_1} = \frac{ae(1+d)+abc}{1+d+eg+bcg+edg}$

Q6 solution

Forward path: $P_1 = ae \quad P_2 = abc$

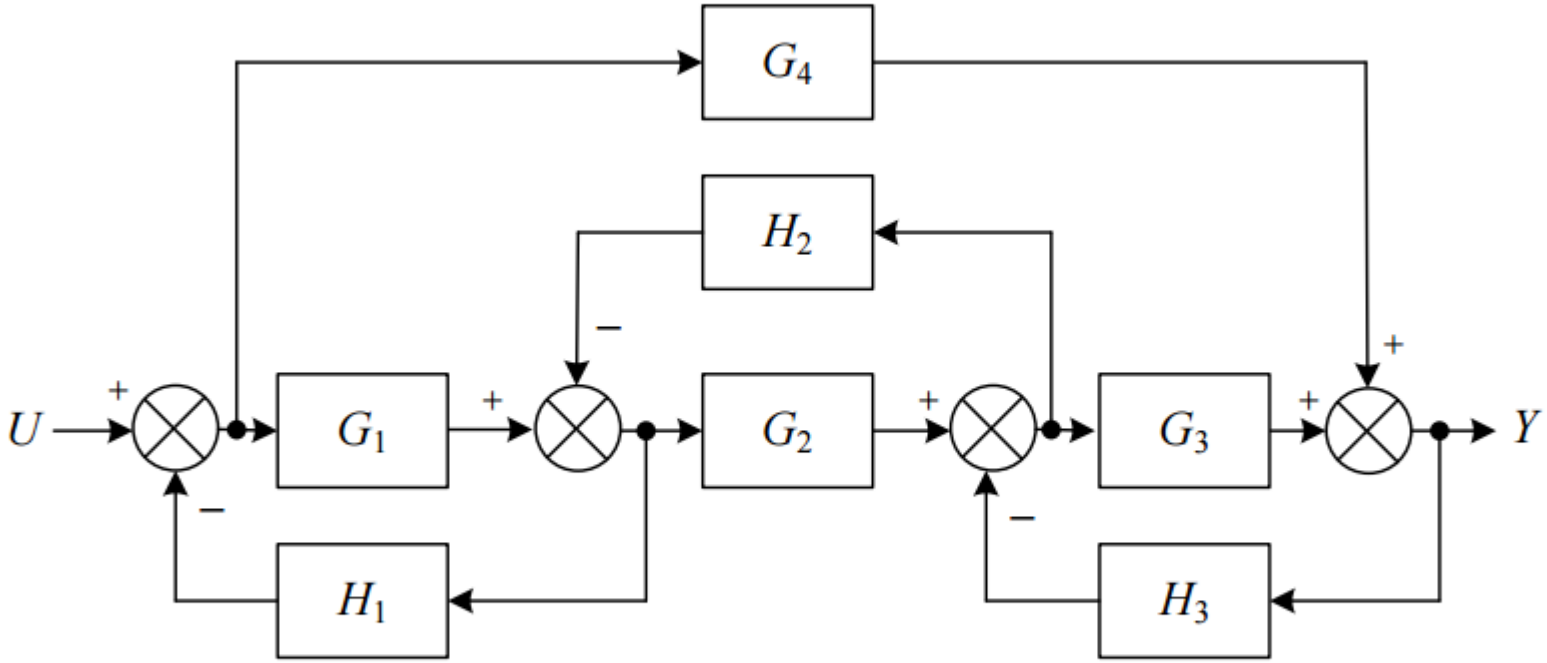
Loops: $L_1 = -eg \quad L_2 = -d \quad L_3 = -bcg$

Hence,

$$\frac{y_4}{y_1} = \frac{P_1\Delta_1 + P_2\Delta_2}{\Delta} = \frac{P_1(1 - L_2) + P_2(1)}{1 - (L_1 + L_2 + L_3) + (L_1L_2)} = \frac{ae(1 + d) + abc}{1 + d + eg + bcg + edg}$$

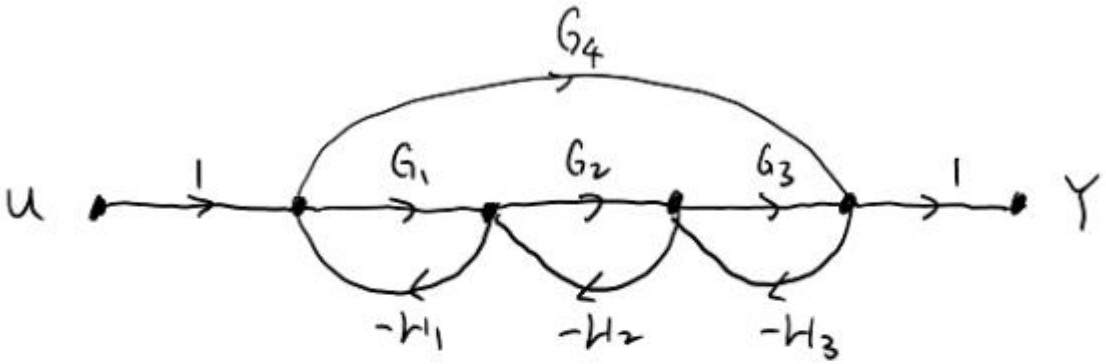
Q7 question

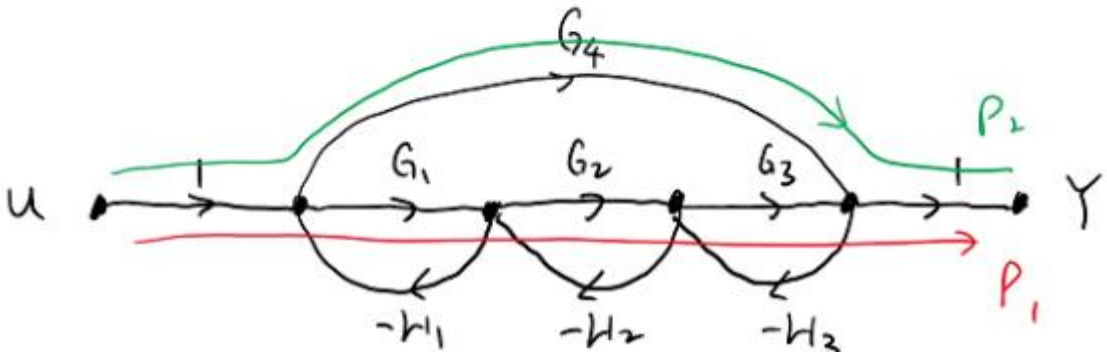
Construct a signal flow graph for the below block diagram and hence determine its transfer function by using Mason's rule.



Ans: $\frac{Y(s)}{U(s)} = \frac{G_1G_2G_3 + G_4 + G_2G_4H_2}{1 + G_1H_1 + G_2H_2 + G_3H_3 + G_4H_1H_2H_3 + G_1G_3H_1H_3}$

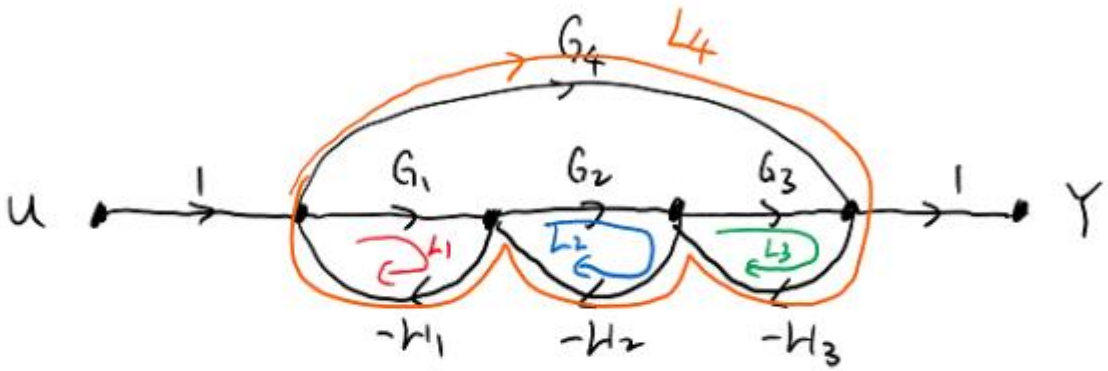
Q7 solution





Forward path:

$$P_1 = G_1G_2G_3 \quad P_2 = G_4$$



Loops:

$$L_1 = -G_1H_1 \quad L_2 = -G_2H_2 \quad L_3 = -G_3H_3 \quad L_4 = -G_4H_1H_2H_3$$

Hence,

$$\frac{Y}{U} = \frac{P_1\Delta_1 + P_2\Delta_2}{\Delta} = \frac{P_1\Delta_1 + P_2(1 - L_2)}{1 - (L_1 + L_2 + L_3 + L_4) + (L_1L_3)}$$

$$\therefore \frac{Y(s)}{U(s)} = \frac{G_1G_2G_3 + G_4(1 + G_2H_2)}{1 + G_1H_1 + G_2H_2 + G_3H_3 + G_4H_1H_2H_3 + G_1G_3H_1H_3}$$