THE UNIVERSITY OF TEXAS AT SAN ANTONIO
EE 3413
ANALYSIS AND DESIGN OF CONTROL SYSTEMS

HOMEWORK # 4 SOLUTION

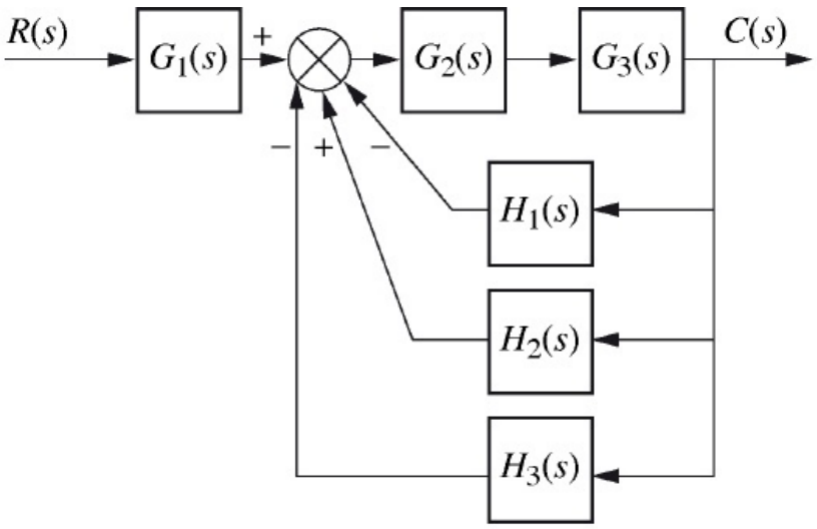
Ahmad F. Taha

February 9, 2016

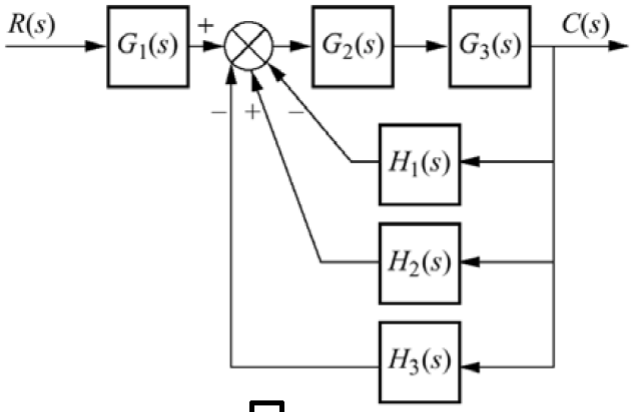
The objective of this homework is to test your understanding of the content of Module 4. Due date of the homework is: **Friday, February 12th, 2016.**

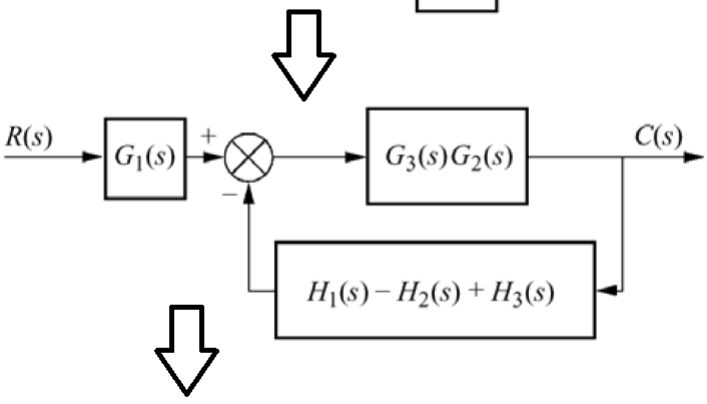
You have to upload a scanned version of your solutions on Blackboard. If you don't have a scanner around you, you can use Cam Scanner—a mobile app that scans images in a neat way, as if they're scanned through a copier. Here's the link for Cam Scanner: https://www.camscanner.com/user/download.

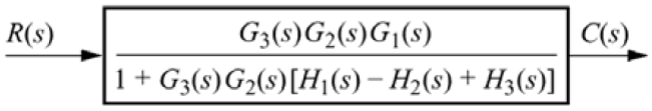
Find the transfer functions for the following block diagrams:

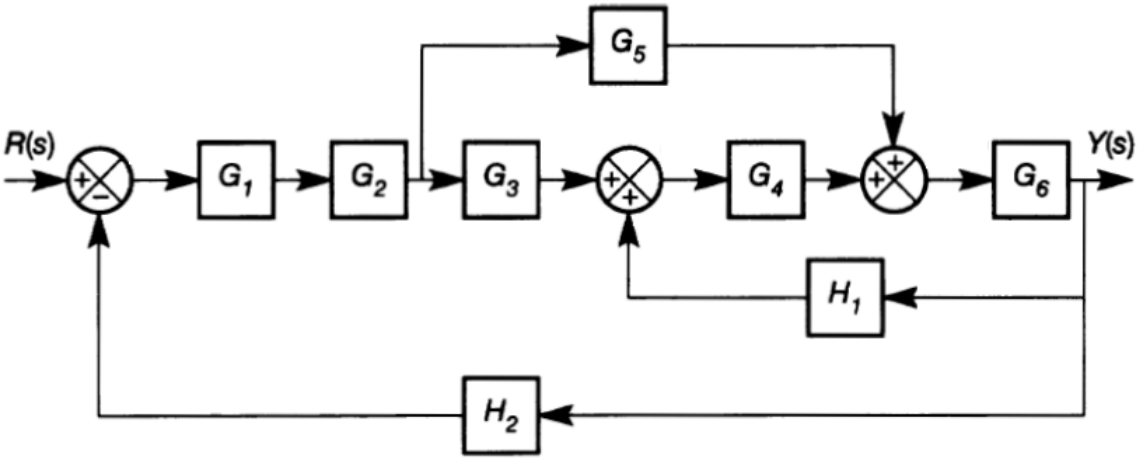


Solution:

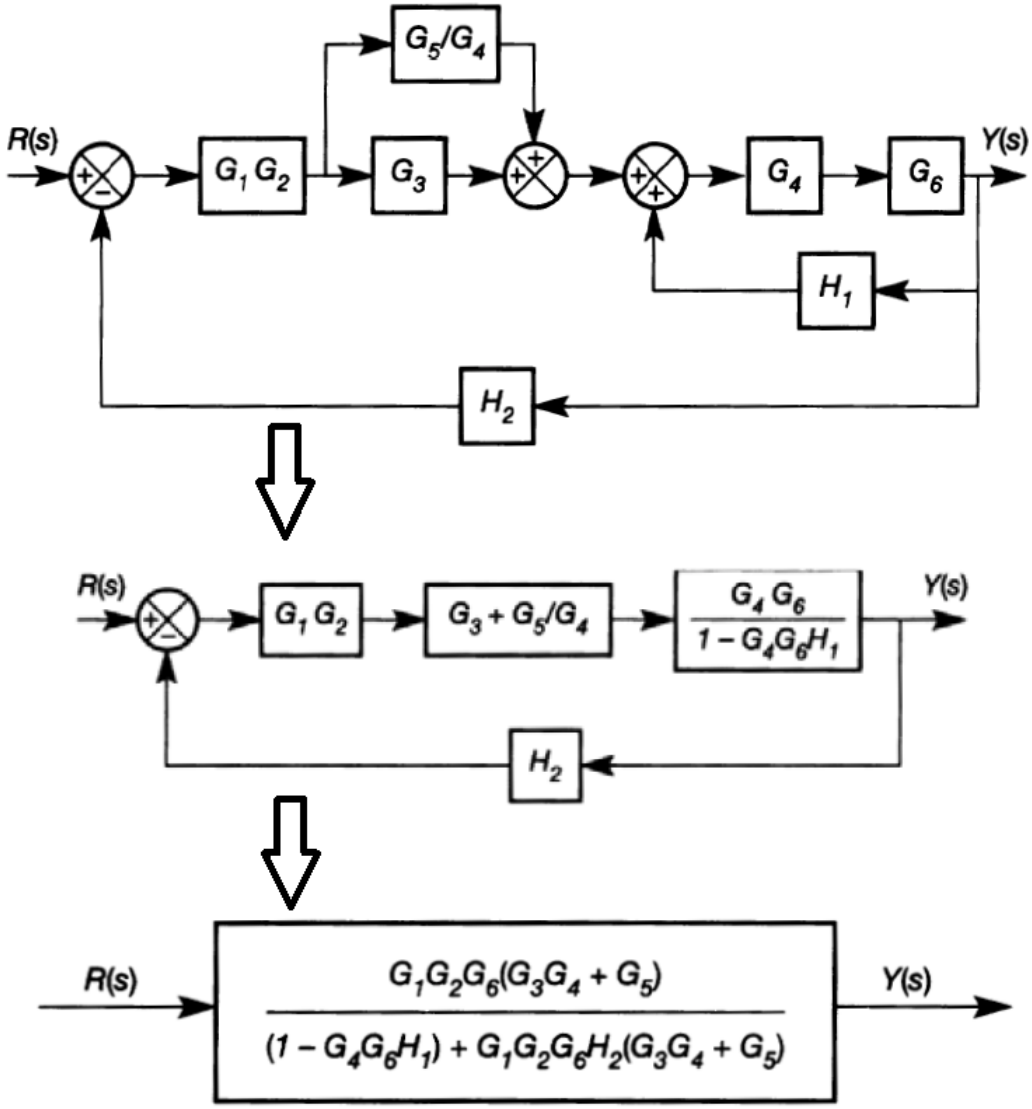

R(s)
G1(s)
+
G2(s)
G3(s)
C(s)
−
+
−
H1(s)
H2(s)
H3(s)

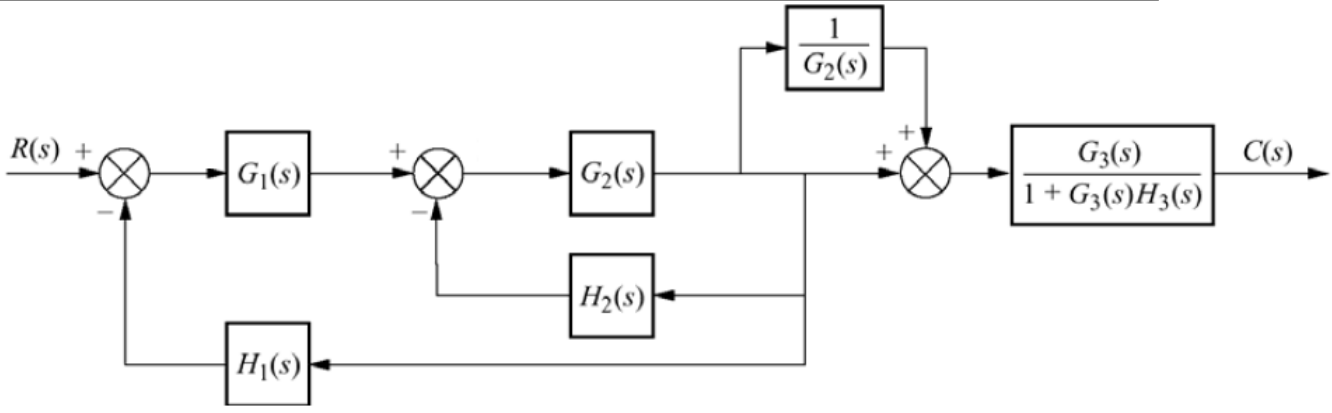

R(s)
G1(s)
+
−
G3(s)G2(s)
C(s)
H1(s) − H2(s) + H3(s)


R(s)
G3(s)G2(s)G1(s)
1 + G3(s)G2(s)[H1(s) − H2(s) + H3(s)]
C(s)

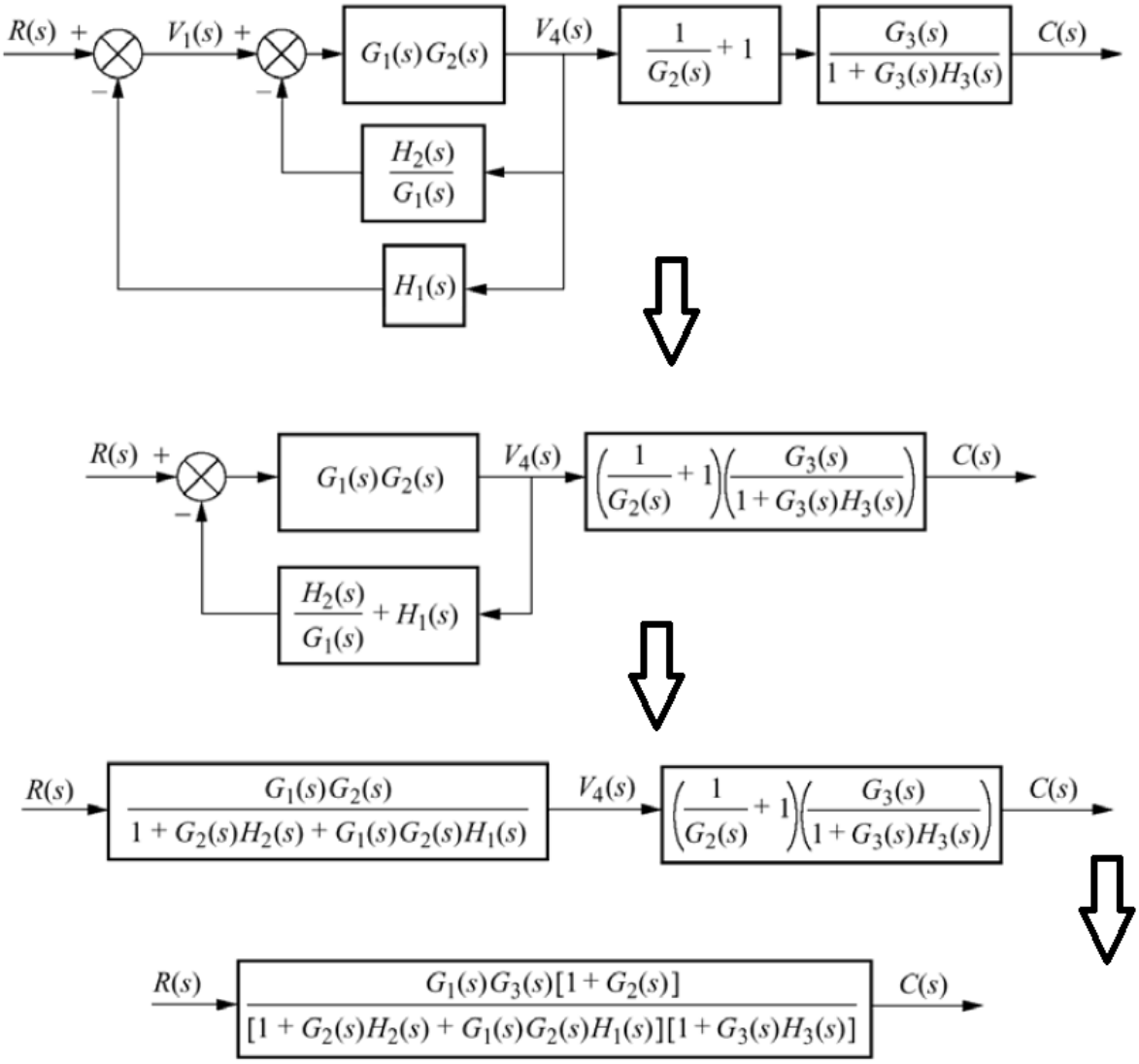

G5
R(s)
G1
G2
G3
G4
G6
Y(s)
H1
H2

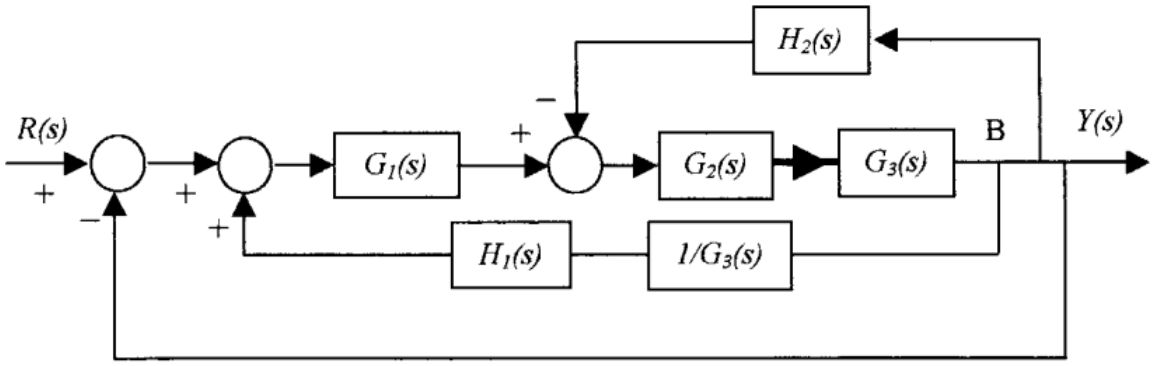
Solution:


R(s)
G_5/G_4
G_1G_2
G_3
G_4
G_6
Y(s)
H_1
H_2
R(s)
G_1G_2
$G_3 + G_5/G_4$
$\frac{G_4G_6}{1 - G_4G_6H_1}$
Y(s)
H_2
R(s)
$\frac{G_1G_2G_6(G_3G_4 + G_5)}{(1 - G_4G_6H_1) + G_1G_2G_6H_2(G_3G_4 + G_5)}$
Y(s)

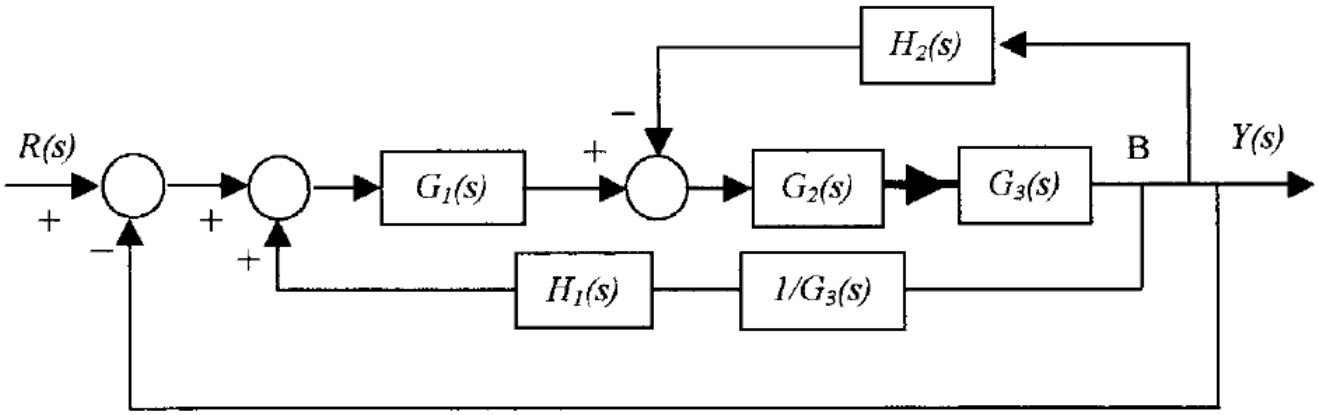

R(s)
$G_1(s)$
$G_2(s)$
$\frac{1}{G_2(s)}$
$\frac{G_3(s)}{1 + G_3(s)H_3(s)}$
C(s)
$H_2(s)$
$H_1(s)$

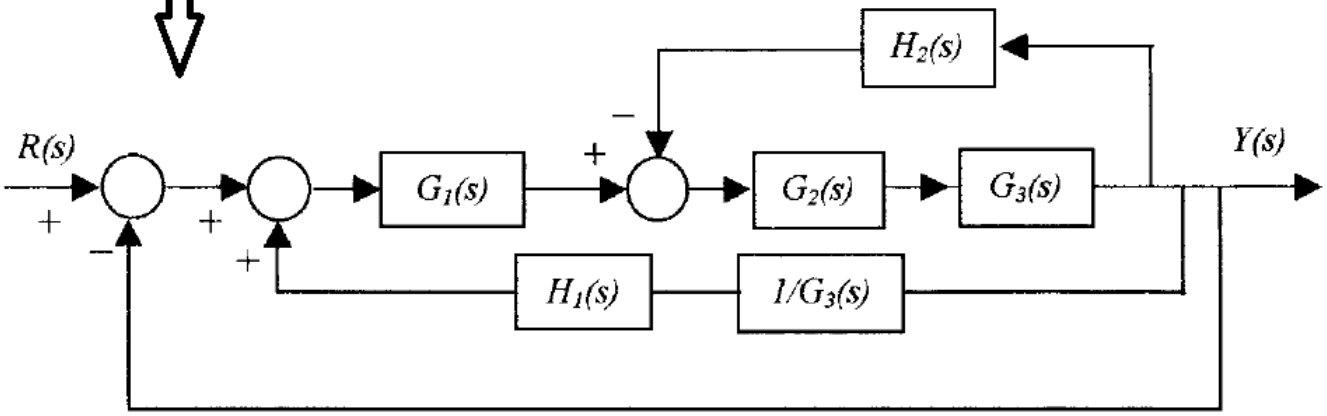
Solution:

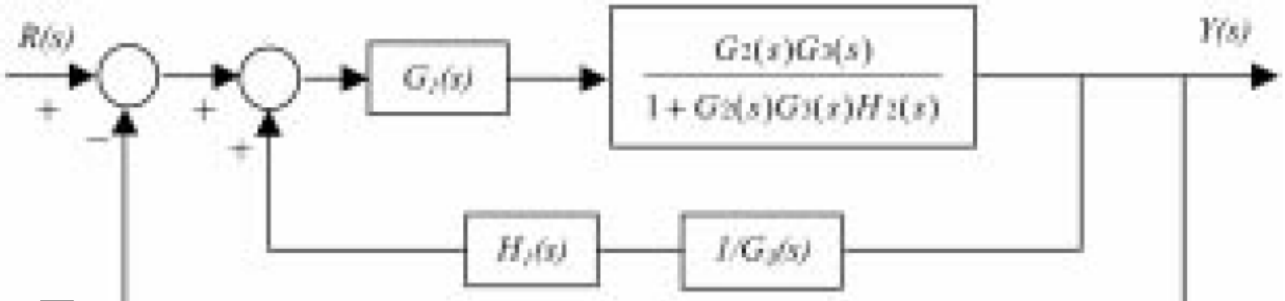

R(s)
V1(s)
G1(s)G2(s)
V4(s)
1/G2(s) + 1
G3(s)/(1 + G3(s)H3(s))
C(s)
H2(s)/G1(s)
H1(s)
R(s)
G1(s)G2(s)
V4(s)
(1/G2(s) + 1)(G3(s)/(1 + G3(s)H3(s)))
C(s)
H2(s)/G1(s) + H1(s)
R(s)
G1(s)G2(s)/(1 + G2(s)H2(s) + G1(s)G2(s)H1(s))
V4(s)
(1/G2(s) + 1)(G3(s)/(1 + G3(s)H3(s)))
C(s)
R(s)
G1(s)G3(s)[1 + G2(s)]/[1 + G2(s)H2(s) + G1(s)G2(s)H1(s)][1 + G3(s)H3(s)]
C(s)

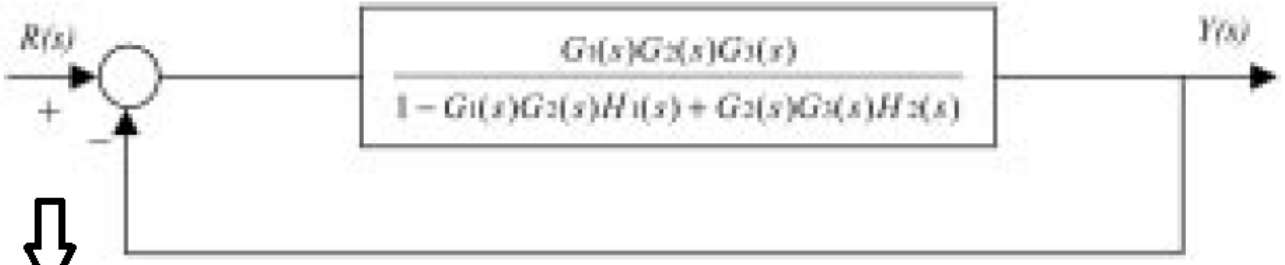

H2(s)
R(s)
G1(s)
G2(s)
G3(s)
B
Y(s)
H1(s)
1/G3(s)

Solution:


R(s)
Y(s)
B
G1(s)
G2(s)
G3(s)
H2(s)
H1(s)
1/G3(s)


R(s)
Y(s)
G1(s)
G2(s)
G3(s)
H2(s)
H1(s)
1/G3(s)


R(s)
Y(s)
G1(s)
$\frac{G_2(s)G_3(s)}{1+G_2(s)G_3(s)H_2(s)}$
H1(s)
1/G1(s)


R(s)
Y(s)
$\frac{G_1(s)G_2(s)G_3(s)}{1-G_1(s)G_2(s)H_1(s)+G_2(s)G_3(s)H_2(s)}$

R(s)
Y(s)
$\frac{G_1(s)G_2(s)G_3(s)}{1-G_1(s)G_2(s)H_1(s)+G_2(s)G_3(s)H_2(s)+G_1(s)G_2(s)G_3(s)}$