Control Systems LAB Digital Assignment 1

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Faculty: **Professor Dhanamjayalu C**

Course: **EEE-3001**

Course Name: **Control Systems Lab**

Lab Slot: **L45 + L46**

Block Diagram Reduction

Exp No: 1

Date: 12-01-2022

AIM

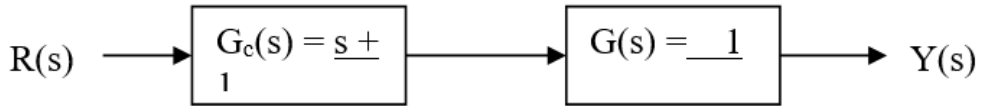
1. To reduce the given Block diagram to transfer function model using M-file Editor in MATLAB.

APPARATUS REQUIRED

1. Personal Computer with MATLAB

THEORY

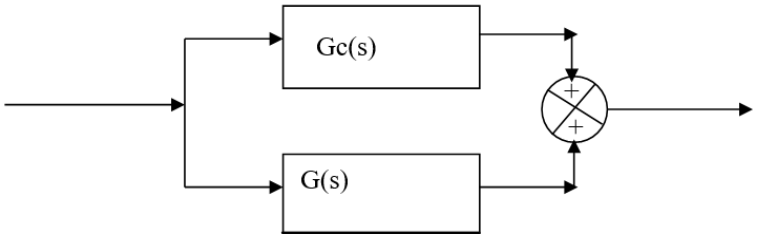
1. It is a representation of the control system giving the inter-relation between the transfer function of various components. The block diagram is obtained after obtaining the differential equation Transfer function of all components of a control system. The arrow head pointing towards the block indicates the i/p pointing away from the block indicates the o/p. After obtaining the block diagram for each every component, all blocks are combined to obtain a complete representation. It is then reduced to a simple form with the help of block diagram algebra.
2. Blocks connected in Series
   (a) Let the process represented by the transfer function G(s) be G(s) = $\frac{S+1}{500S^2}$. and let the controller represented by the transfer function Gc(s) be Gc(s) = $\frac{S+1}{S+2}$ .Compute the series transfer function Gc(s)G(s)



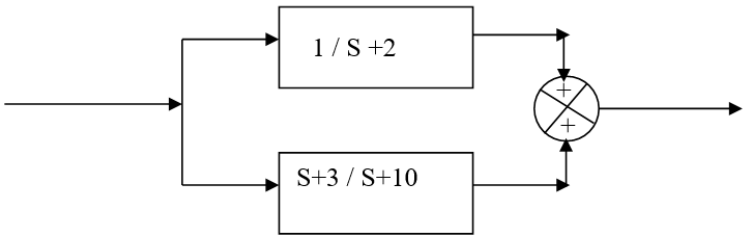

```
≫numg=[1]; deng = [500 0 0];
≫numh=[1 1]; denh = [1 2]
≫[num, den]= series(numg,deng,numh,denh);
≫printsys(num,den)
```

   (b) Output of the program is $\frac{S+1}{500s^3+1000s^2}$
3. Blocks connected in Parallel

(a) A simple open – loop control system can be obtained by interconnecting a plant and a controller in parallel.



(b) The transfer function in this case is Gc(s)+G(s).Let the process represented by the transfer function G(s) be G(s) = $\frac{1}{S+2}$.and let the controller represented by the transfer function Gc(s) be Gc(s) = $\frac{S+3}{S+10}$. Compute the combined transfer function of the blocks

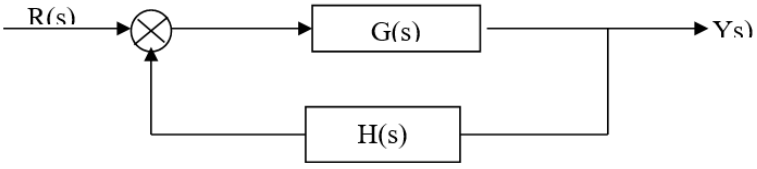



```
»num1 = 1;
»den1 =[1 2];
»num2 =[1 3];
»den2 =[1 10];
» [nump, denp] = parallel(num1, den1, num2, den2);
»printsys (nump, denp, 's');
```

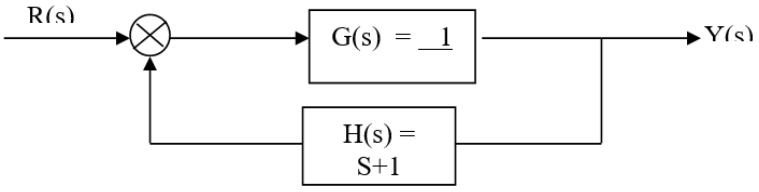
(c) Execution of the above yields the result $\frac{S^2+6S+16}{S^2+12S+20}$

4. Feedback Function

(a) This function reduces the process of computing the closed loop transfer function for single or multiple loops.



5. Single Loop example



(a) Program code

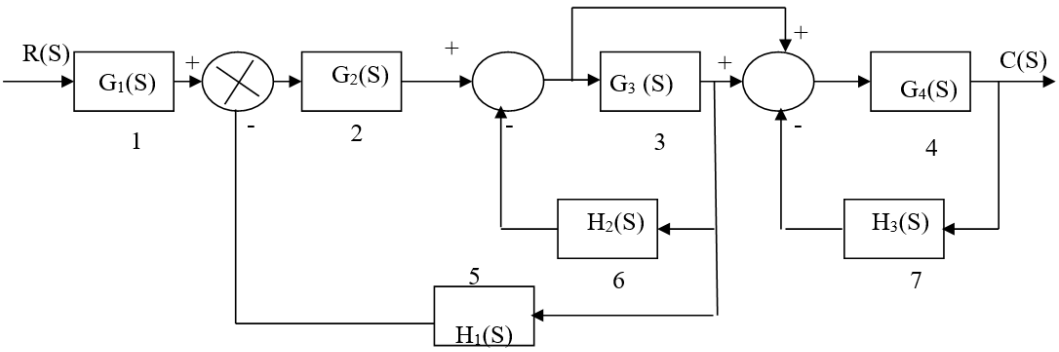
```
» numg = [1] ; deng = [500  0  0];
» numh = [1  1 ] ;  denh = [ 1  2 ];
» [num, den] = feedback(numg,deng,numh,denh,-1);
» printsys(num, den)
```

(b) Output of the program is Transfer function = $\frac{S+2}{500S^3+1000S^2+S+1}$

PROCEDURE

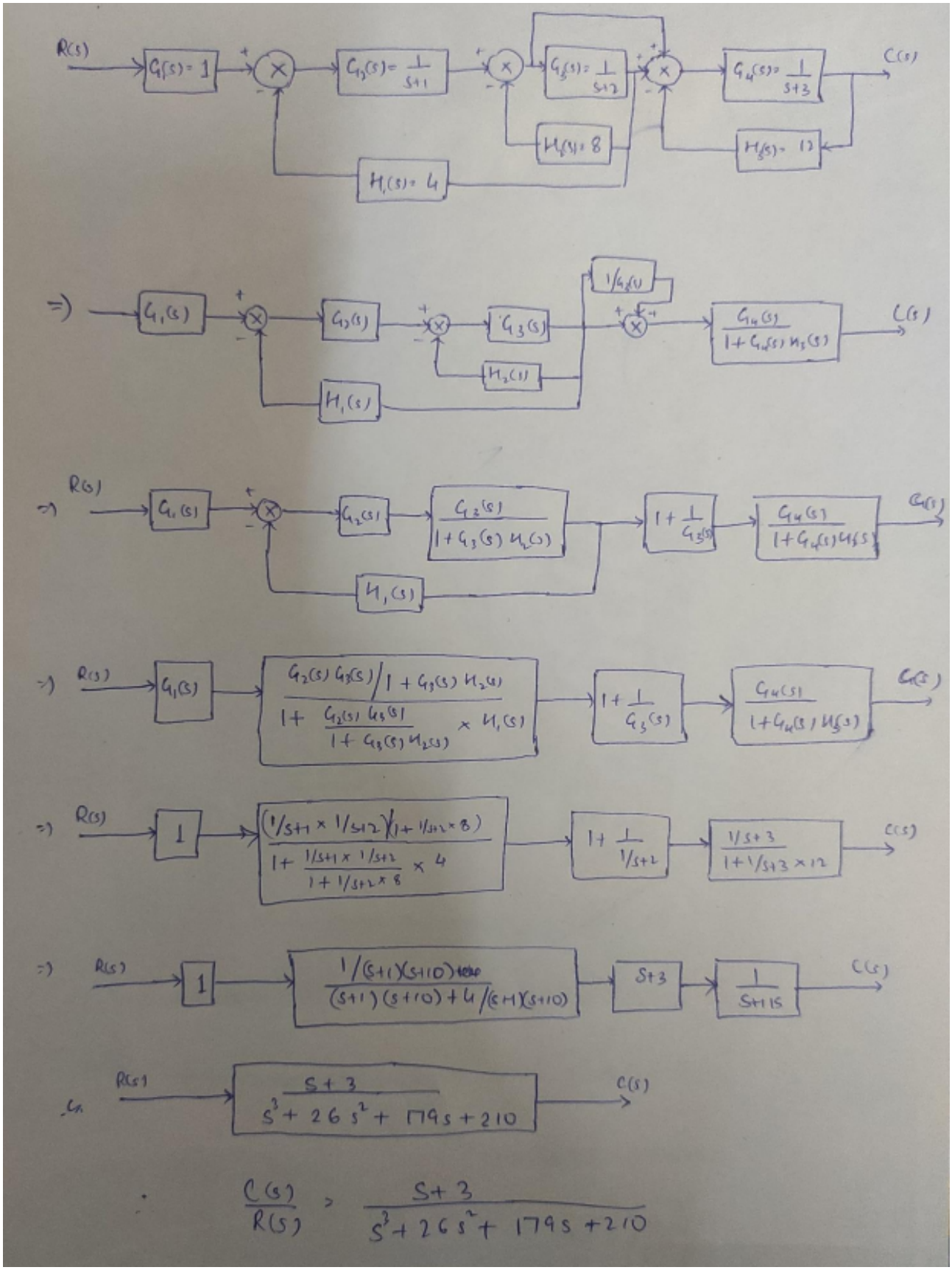
1. Enter the command window of the MATLAB
2. Create a new M – file by selecting File – New – M – File.
3. Type and save the program.
4. Execute the program by either pressing F5 or Debug – Run.
5. View the results.
6. Analysis the stability of the system.
7. For reducing very complex systems, blkbuild and connect commands are used as illustrated below; BLKBUILD Builds a block-diagonal state-space structure from a block diagram of transfer functions and state models. This is a SCRIPT FILE. Each block is numbered as shown. In the first seven lines of the program, the above blocks are completely defined. The numbers of blocks are then defined n blocks. The command blkbuild uses the variable nblocks to begin building the system. It converts all the transfer functions to state space models and assembles them into one large block state space model called a, b, c, d. The next step is to create the matrix q that describes the interconnections of various blocks. Each row corresponds to a block and the first element in the row is the block number and the remaining elements indicate the blocks whose outputs are connected to the input of the current block. After defining q, the block 1 that receives the system input and block 4 that produces the system output are defined by the variables 'input' and 'output'. The connect command makes the connections and reduces the system into a single state space model which is then converted back into transfer function
8. Inputs
   (a) nblocks $\rightarrow$ is the number of blocks in the diagram
   (b) ni and di $\rightarrow$ are the numerator and denominator polynomials for the ith block if it is a transfer function.
   (c) ai,bi,ci,di $\rightarrow$ are the state matrices for the ith block if it is a state model.
9. Output
   (a) a,b,c,d $\rightarrow$ is the resulting state space structure. The matrices are built up by progressive APPENDs of the state

PROBLEM



Let G1(s) = 1 G2(s) = 1/(s+1),
G3(s) = 1/(s+2) G4(s) = 1/(s+3),
H1(s) = 4 H2(s) = 8, H3(s) = 12,

```
clc;
clear all;
n1=1; d1=1;
n2=1; d2=[1 1];
n3=1; d3=[1 2]; %Block 3
n4=1; d4=[1 3];
n5=4; d5=1; %Block 5
n6=8; d6=1;
n7=12; d7=1;
input=1;
output=4;
nblocks=7;
blkbuild;
q= [2 1 -5 0 0
3 2 -6 0 0
4 3 -7 2 -6
5 3 0 0 0
6 3 0 0 0
7 4 0 0 0];
[aa,bb,cc,dd]=connect(a,b,c,d,q,input,output);
[num,den]=ss2tf(aa,bb,cc,dd);
printsys(num,den,'s')
```


R(s)
G1(s) = 1
G2(s) = 1/(s+1)
G3(s) = 1/(s+2)
G4(s) = 1/(s+3)
C(s)
H1(s) = 4
H2(s) = 8
H3(s) = 12
=>
G1(s)
G2(s)
G3(s)
H1(s)
H2(s)
1/G3(s)
G4(s)/(1+G4(s)H3(s))
C(s)
=>
R(s)
G1(s)
G2(s)
G2(s)/(1+G3(s)H2(s))
1+1/G3(s)
G4(s)/(1+G4(s)H3(s))
C(s)
H1(s)
=>
R(s)
G1(s)
G2(s)G3(s)/(1+G3(s)H2(s)) / (1+G2(s)G3(s)/(1+G3(s)H2(s)) x H1(s))
1+1/G3(s)
G4(s)/(1+G4(s)H3(s))
C(s)
=>
R(s)
1
(1/s+1 x 1/s+2)/(1+1/s+2 x 8) / (1+1/s+1 x 1/s+2)/(1+1/s+2 x 8) x 4
1+1/(1/s+2)
(1/s+3)/(1+1/s+3 x 12)
C(s)
=>
R(s)
1
1/(s+1)(s+10) / (s+1)(s+10)+4/(s+1)(s+10)
s+3
1/(s+13)
C(s)
R(s)
(s+3)/(s^3+26s^2+179s+210)
C(s)
C(s)/R(s) = (s+3)/(s^3+26s^2+179s+210)

SYSTEM RESPONSE

1. State model [a,b,c,d] of the block diagrams has 7 inputs and 7 outputs
2. num/den = $\frac{S+3}{S^3+26S^2+179S+210}$