Simplificação de Diagrama de Blocos

24/05/2025.

Reducing multiple subsystems using 'append' and 'connect'

Skill-Assessment Exercise 5.1

Coletado do livro Nise 6ª edição (2011)

Skill-Assessment Exercise 5.1

PROBLEM: Find the equivalent transfer function, $T(s) = C(s)/R(s)$, for the system shown in Figure 5.13.

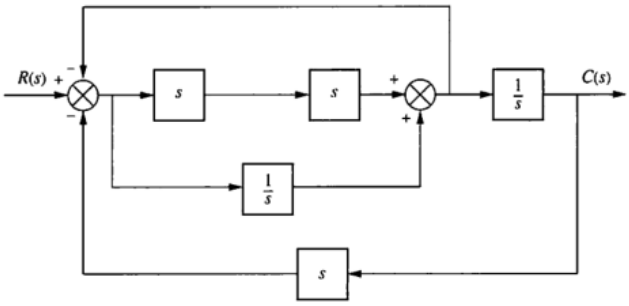


FIGURE 5.13 Block diagram for Skill-Assessment Exercise 5.1

ANSWER:

$$T(s) = \frac{s^3 + 1}{2s^4 + s^2 + 2s}$$

The complete solution is at www.wiley.com/college/nise.

TryIt 5.1

Use the following MATLAB and Control System Toolbox statements to find the closed-loop transfer function of the system in Example 5.2 if all $G_i(s) = 1/(s+1)$ and all $H_i(s) = 1/s$.

```
G1=tf(1,[1 1]);
G2=G1;G3=G1;
H1=tf(1,[1 0]);
H2=H1;H3=H1;
System=append...
 (G1,G2,G3,H1,H2,H3);
input=1;output=3;
Q=[1  -4   0   0   0
   2   1  -5   0   0
   3   2   1  -5  -6
   4   2   0   0   0
   5   2   0   0   0
   6   3   0   0   0];
T=connect(System,...
 Q,input,output);
T=tf(T);T=minreal(T)
```

Note que o código apresentado no lado direito, refere-se ao exemplo 5.2 apontado abaixo

Example 5.2

Block Diagram Reduction by Moving Blocks

PROBLEM: Reduce the system shown in Figure 5.11 to a single transfer function.

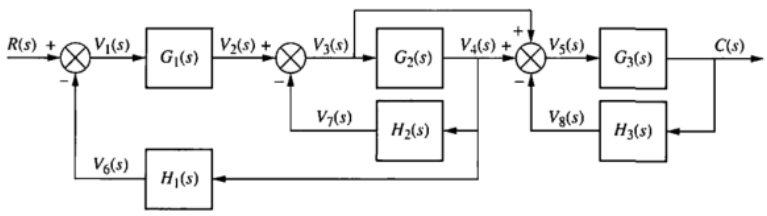


FIGURE 5.11 Block diagram for Example 5.2

```
Gl=tf(l,[l 1]);
G2=G1;G3=G1;
Hl=tf(l,[l 0]);
H2=H1;H3=H1;
System=append (G1,G2,G3,H1,H2,H3);
input = l ; output = 3 ;
Q = =[1 -4 0 0 0
```

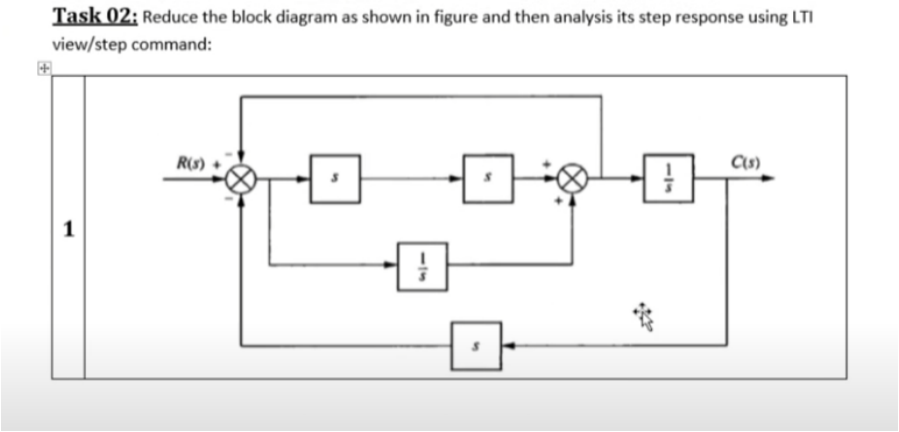
```
2 1 -5 0 0
3 2 1 -5 -6
4 2 0 0 0
5 2 0 0 0
6 3 0 0 0];
T=connect(System,Q, input, output);
T=tf(T); T=minreal(T)
```

Solução apontada no Apêndice

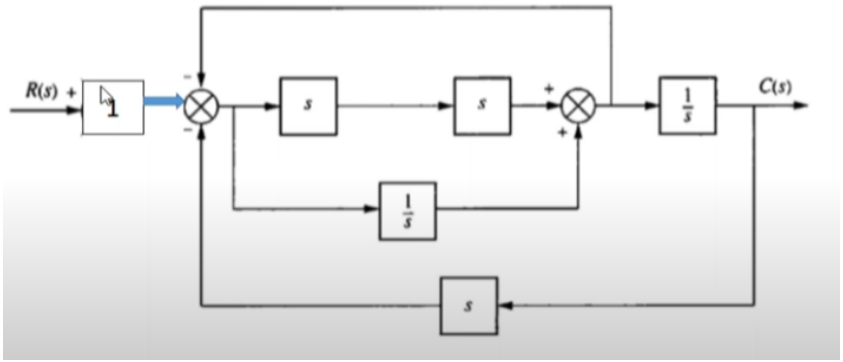
```
'Tente Implementar 5.1'
G1=tf(1,[1 1]);
G2=G1;G3=G1;
H1=tf(1,[1 0]);
H2=H1;H3=H1;
sistema=append...
(G1,G2,G3,H1,H2,H3);
entrada=1;saida=3;
Q=[1 -4 0 0 0
   2 1 -5 0 0
   3 2 1 -5 -6
   4 2 0 0 0
   5 2 0 0 0
   6 3 0 0 0];
T=connect(sistema,Q,...
entrada,saida);
T=tf(T);T=minreal(T)
```

Outra forma de Resolução

Discussão sobre forma melhor de resolução em
MATLAB URDU part-I and II
https://www.youtube.com/watch?v=kLP2JbTUCRU [Urdu]
https://www.youtube.com/watch?v=EHklJsJF_eA [Urdu]



Modifique neste momento, para melhor resultado




```
clc; clear all
s = tf('s');
G1=s;
G2=s;
G3=1/s;
G4=1/s;
G5=s;
G6=1;
T = append (G1, G2, G3, G4,G5, G6)
input=6;
output = 3
q = [ 1 -2 -4 -5 6;
2 1 0 0 0
3 2 4 0 0
4 -2 -4 -5 6;
5 3 0 0 0];
Ts = connect(T, q, input, output);
T = tf(Ts)
minreal(T)
```

Resposta esperada

$$T = \frac{s^3 + 1}{2s^4 + s^2 + 2s}$$

Resultados ao aplicar desta forma

ans =

```
  0.5 s^3 + 2.776e-15 s^2 - 6.661e-16 s + 0.5
  -------------------------------------------
     s^4 + 3.109e-15 s^3 + 0.5 s^2 + s
```

Note que é o mesmo do apresentado acima com diferença do fator 2 dividindo tudo.
Valores baixos como 2.776e-15 s^2 e 3.109e-15 s^3, são desprezados

Problema 5

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5. Find the transfer function, $T(s) = C(s)/R(s)$, for the system shown in Figure P5.5. Use the following methods:

   a. Block diagram reduction [Section: 5.2]

   b. MATLAB. Use the following transfer functions:
   $G_1(s) = 1/(s+7)$, $G_2(s) = 1/(s^2+2s+3)$,
   $G_3(s) = 1/(s+4)$, $G_4(s) = 1/s$,
   $G_5(s) = 5/(s+7)$, $G_6(s) = 1/(s^2+5s+10)$,
   $G_7(s) = 3/(s+2)$, $G_8(s) = 1/(s+6)$.
   Hint: Use the **append** and **connect** commands in MATLAB's Control System Toolbox.

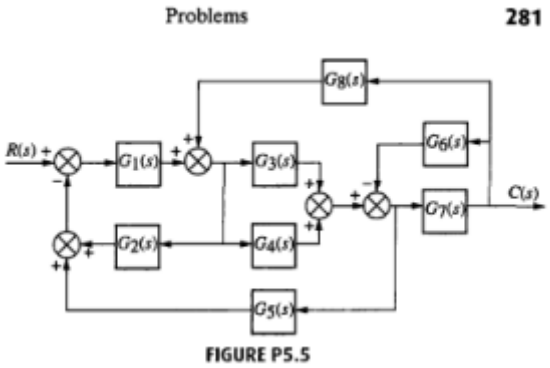

FIGURE P5.5

```
G1=tf([0 1],[1 7]); %G1=1/s+7 input transducer
G2=tf([0 0 1],[1 2 3]); %G2=1/s^2+2s+3
G3=tf([0 1],[1 4]); %G3=1/s+4
G4=tf([0 1],[1 0]); %G4=1/s
G5=tf([0 5],[1 7]); %G5=5/s+7
G6=tf([0 0 1],[1 5 10]); %G6=1/s^2+5s+10
G7=tf([0 3],[1 2]); %G7=3/s+2
G8=tf([0 1],[1 6]); %G8=1/s+6
G9=tf([1],[1]); %Add G9=1 transducer at the input
T1=append(G1,G2,G3,G4,G5,G6,G7,G8,G9);
Q=[1 -2 -5 9
2 1 8 0
3 1 8 0
4 1 8 0
5 3 4 -6
6 7 0 0
7 3 4 -6
8 7 0 0];
inputs=9;
outputs=7;
Ts=connect(T1,Q,inputs,outputs);
T=tf(Ts)
```