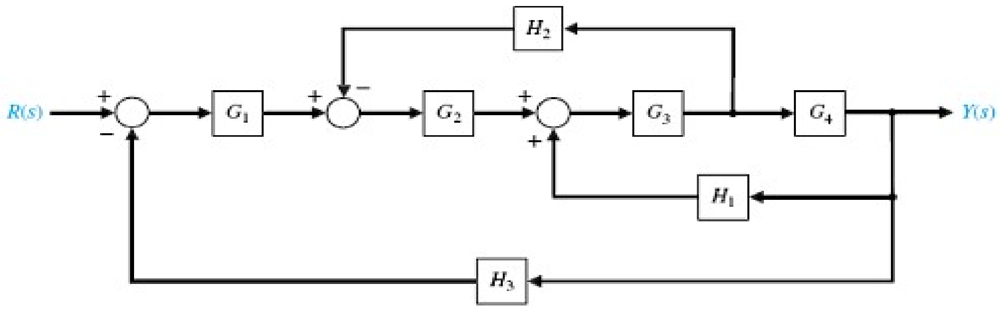
TASKS

Exercise 1:

For the following multi-loop feedback system, get closed loop transfer function and the corresponding pole-zero map of the system. Using MATLAB plot the pole zero map of the above system.



$$G_1 = \frac{1}{(s+10)}; G_2 = \frac{1}{(s+1)}; G_3 = \frac{s^2+1}{(s^2+4s+4)}; G_4 = \frac{s+1}{(s+6)};$$

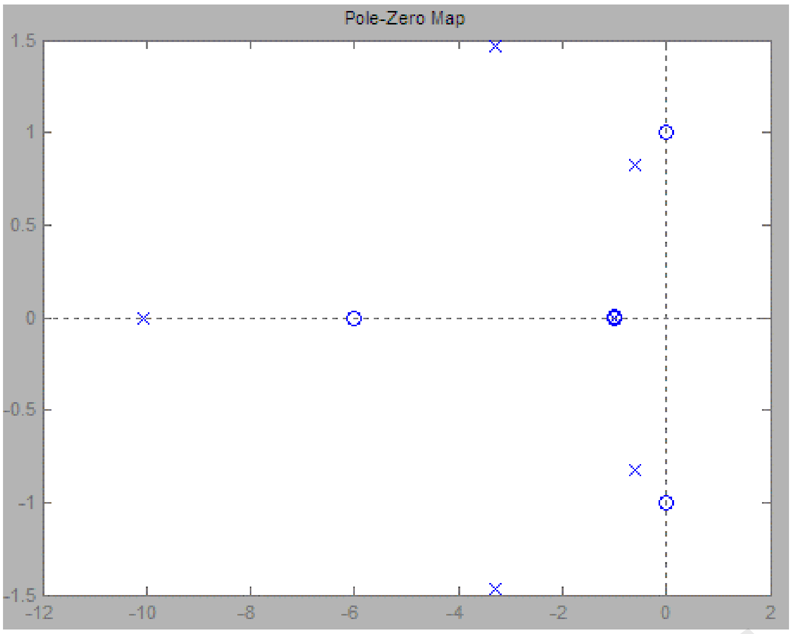
$$H_1 = \frac{s+1}{(s+6)}; H_2 = 2; H_3 = 1$$

Solution:

Command Window

```
>> num1=[1]; dum1=[1 10]; sysg1=tf(num1,dum1);
num2=[1]; dum2=[1 1]; sysg2=tf(num2,dum2);
num3=[1 0 1]; dum3=[1 4 4]; sysg3=tf(num3,dum3);
num4=[1 1]; dum4=[1 6]; sysg4=tf(num4,dum4);
numh1=[1 1];dumh1=[1 6]; sysh1=tf(numh1,dumh1);
numh2=[2]; dumh2=[1]; sysh2=tf(numh2,dumh2);
numh3=[1]; dumh3=[1]; sysh3=tf(numh3,dumh3);
sys1 =sysh2/sysg4;
sys2=series(sysg3,sysg4);
sys3=feedback(sys2,sysh1 ,+1);
sys4=series(sysg2,sys3);
sys5=feedback(sys4,sys1);
sys6=series(sysg1 ,sys5);
sys=feedback(sys6,sysh3)
pzmap(sys)

sys =

              s^5 + 8 s^4 + 14 s^3 + 14 s^2 + 13 s + 6
  -----------------------------------------------------------------
  16 s^6 + 301 s^5 + 1882 s^4 + 5461 s^3 + 7656 s^2 + 5948 s + 2156

Continuous-time transfer function.
```

pz-map of the system:



Exercise 2:

Consider the feedback system depicted in the figure below

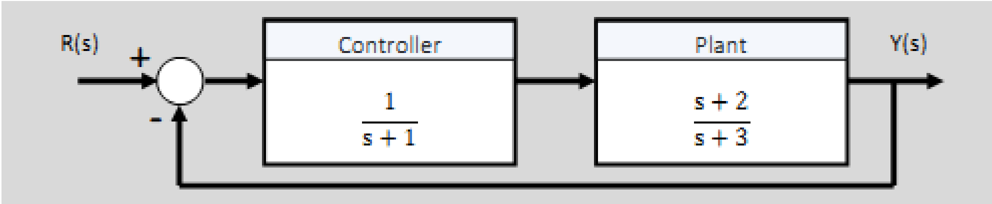
a. Compute the closed-loop transfer function using the 'series' and 'feedback' functions

Solution:

Command Window

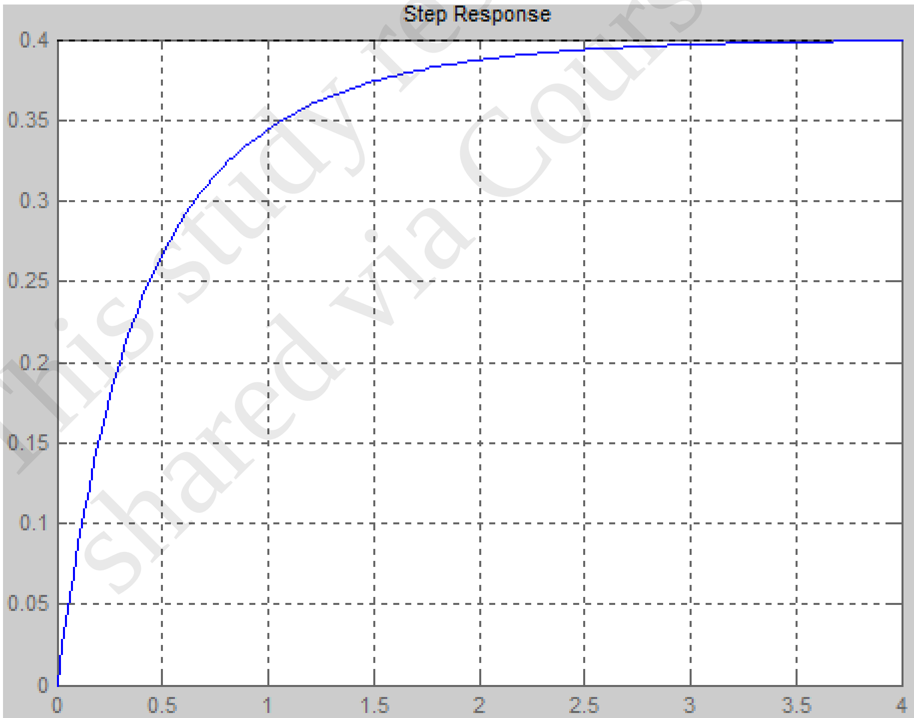
```
>> numc=[1]; dumc=[1 1]; sysc=tf(numc,dumc);
nump=[1 2]; dump=[1 3]; sysp=tf(nump,dump);
syss=series(sysc,sysp)
sysf=feedback(syss,[1])

syss =

      s + 2
  -------------
  s^2 + 4 s + 3

Continuous-time transfer function.


sysf =

      s + 2
  -------------
  s^2 + 5 s + 5

Continuous-time transfer function.
```

b. Obtain the closed-loop system unit step response with the 'step' function and verify that final value of the output is 2/5.



Solution:

```
Command Window
>> numc=[1]; dumc=[1 1]; sysc=tf(numc,dumc);
nump=[1 2]; dump=[1 3]; sysp=tf(nump,dump);
syss=series(sysc,sysp);
sysf=feedback(syss,[1]);
step(sysf);
grid on
>>
```

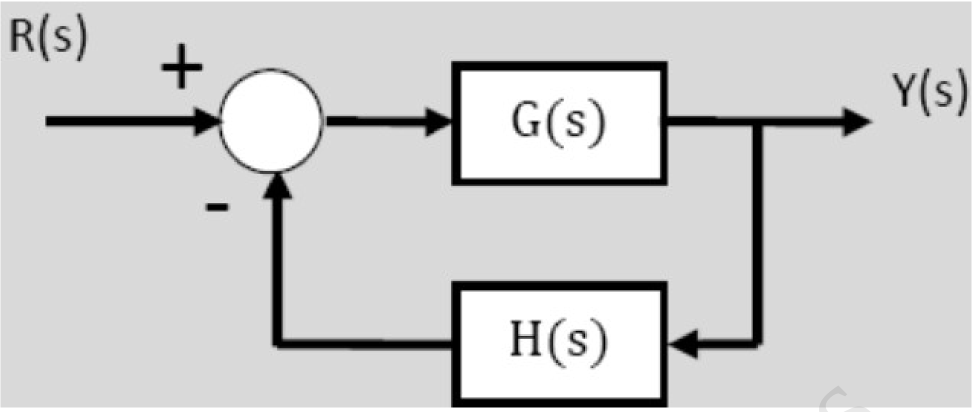


Exercise 3:

Consider the feedback control system given in figure, where

$$G(s) = \frac{s+1}{s+2} \qquad H(s) = \frac{1}{s+1}$$

a. Using an m-file script, determine the close-loop transfer function.
b. Obtain the pole-zero map using the 'pzmap' function. Where are the closed-loop system poles and zeros?



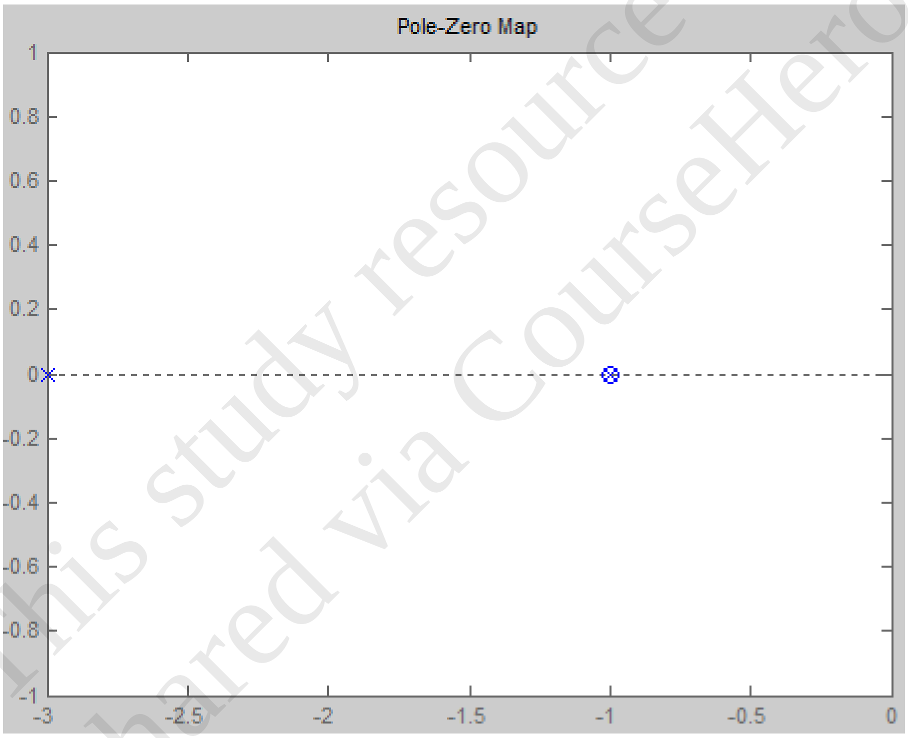
Solution (a):

```
Command Window
>> numg=[1 1]; dumg=[1 2]; sysg=tf(numg,dumg);
numh=[1]; dumh=[1 1]; sysh=tf(numh,dumh);
sys=feedback(sysg,sysh)

sys =

  s^2 + 2 s + 1
  -------------
  s^2 + 4 s + 3

Continuous-time transfer function.
```

Solution (b):

```
Command Window
>> numg=[1 1]; dumg=[1 2]; sysg=tf(numg,dumg);
numh=[1]; dumh=[1 1]; sysh=tf(numh,dumh);
sys=feedback(sysg,sysh);
pzmap(sys)
pole(sys)
zero(sys)

ans =

    -3
    -1


ans =

    -1
    -1
```

pz-map of the system:



By computing the closed-loop transfer function, we get:

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

Therefore:

Poles are s= -3,-1
Zeros are s= -1,-1