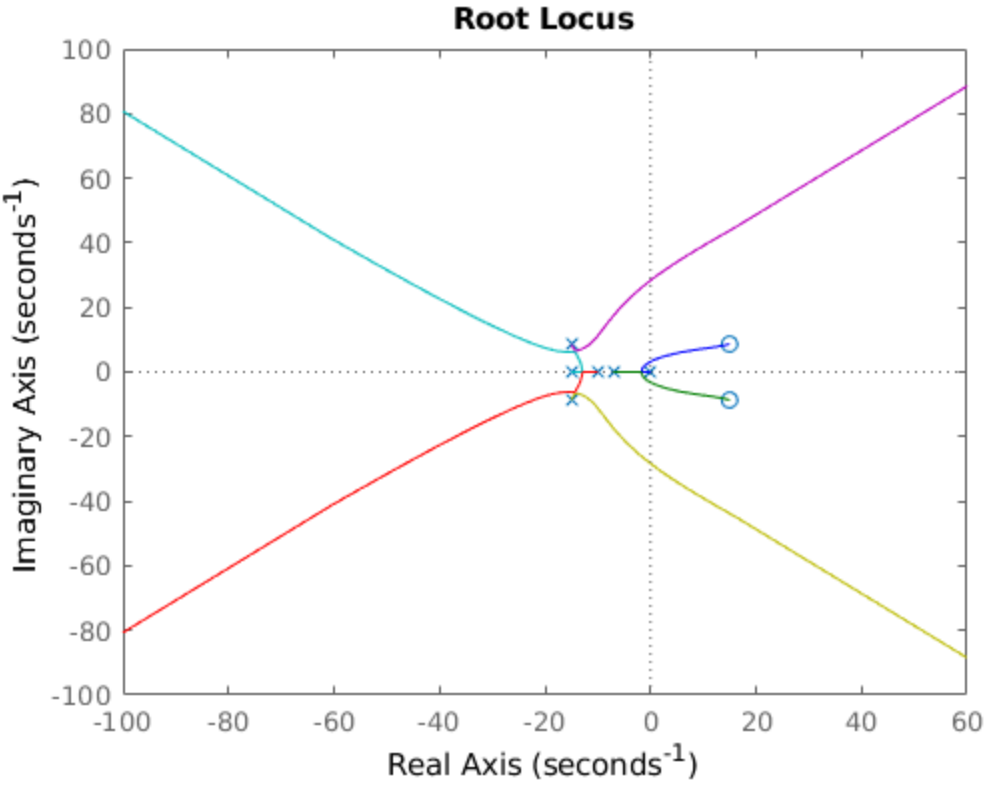
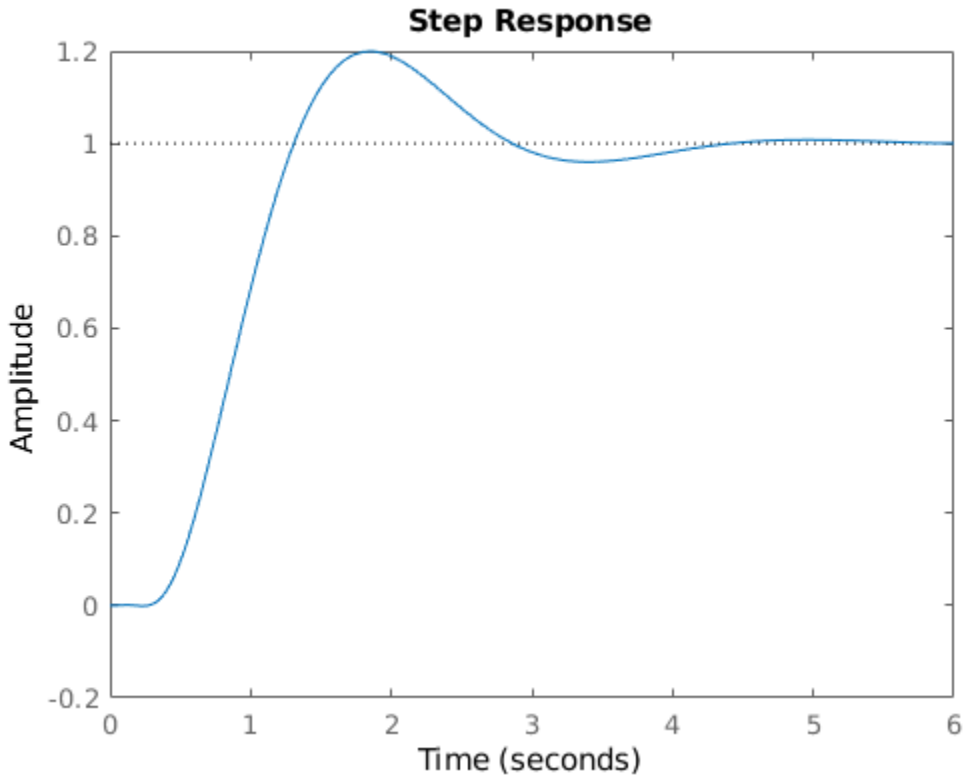
Controls Homework 9 Problem 1

```
G1 = zpk([],[0 -7 -10 -15],[200]);
[num,den] = pade(0.2, 2);
Delay = tf(num,den);
rlocus(G1*Delay);
Gs1 = zpk(G1*Delay)

X1 = evalfr(Gs1, -1.03626 + 2.02270j)
K1 = -1/X1

Gcl1 = minreal(Gs1*abs(K1) / (1 + Gs1*abs(K1)))
roots([ 1 2.908 10.09])
figure;
step(Gcl1)


Gs1 =

           200 (s^2 - 30s + 300)
  ---------------------------------------
  s (s+7) (s+10) (s+15) (s^2 + 30s + 300)

Continuous-time zero/pole/gain model.


X1 =

  -0.1326 - 0.0000i


K1 =

   7.5415 - 0.0000i


Gcl1 =

                        1508.3 (s^2 - 30s + 300)
  ---------------------------------------------------------------------
  (s^2 + 2.073s + 5.165) (s^2 + 38.24s + 415.4) (s^2 + 21.69s + 210.9)

Continuous-time zero/pole/gain model.


ans =

  -1.4540 + 2.8242i
  -1.4540 - 2.8242i
```

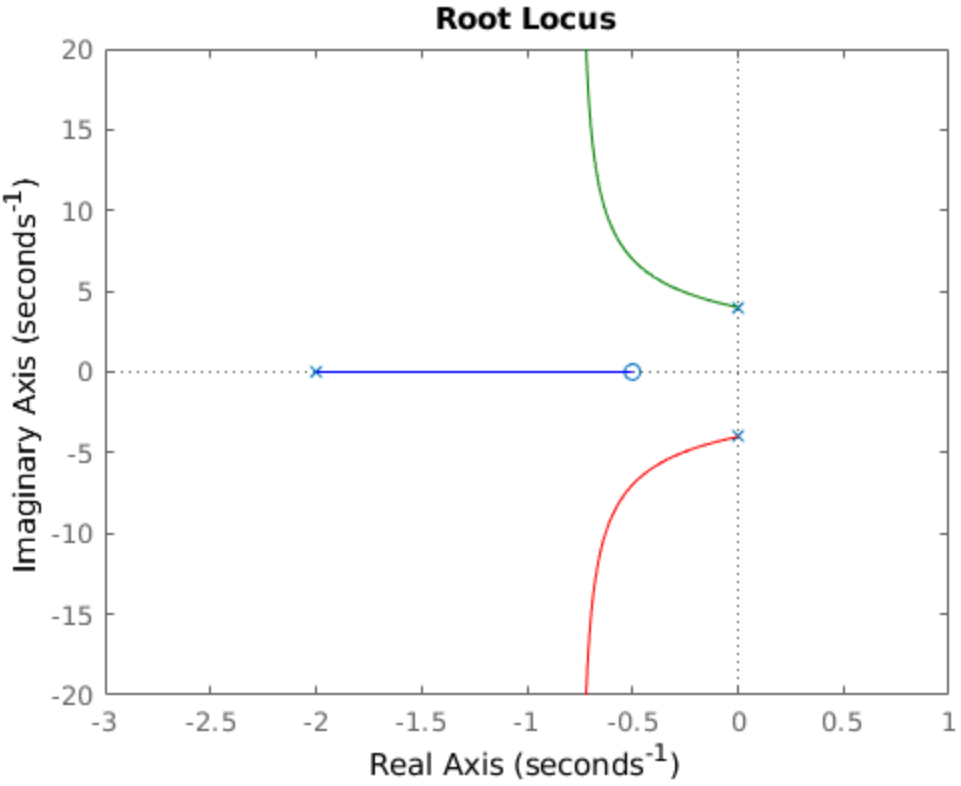

Root Locus
Imaginary Axis (seconds-1)
Real Axis (seconds-1)
100
80
60
40
20
0
-20
-40
-60
-80
-100
-100
-80
-60
-40
-20
0
20
40
60

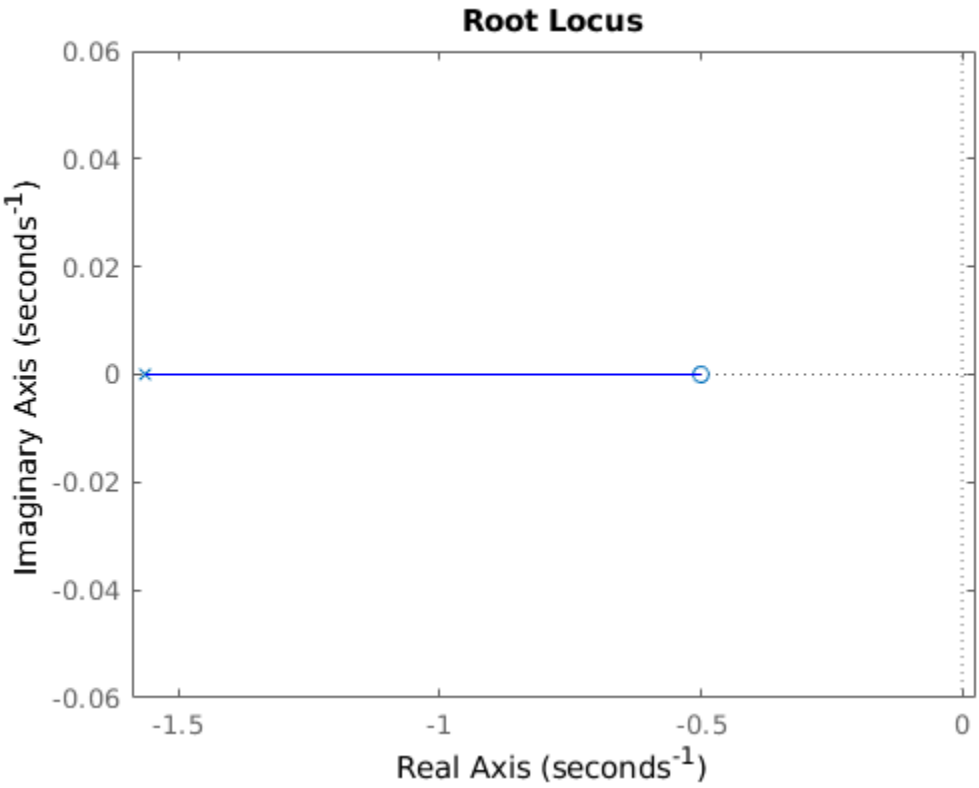

Step Response
Amplitude
Time (seconds)
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
1
2
3
4
5
6

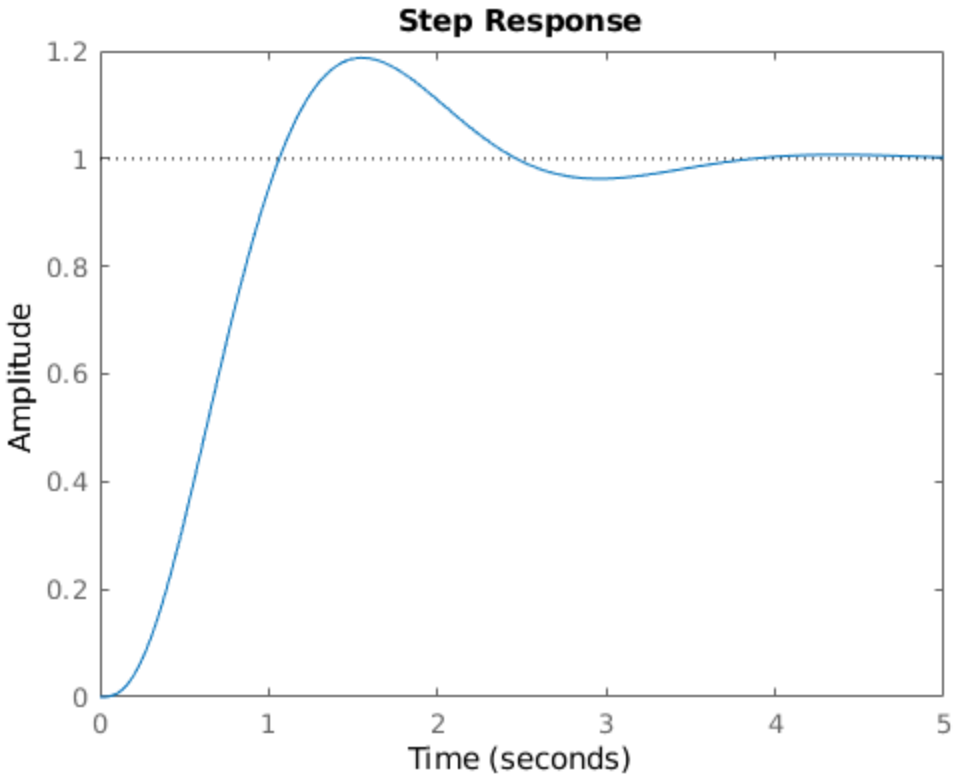
Controls Homework 9 Problem 2

```
% Added s+5 zero to stabilize (no pole needed since extra pole present
G2 = zpk([-.5],[-2 -4j 4j],[200]);
figure;
rlocus(G2)

% Find first K
X2_1 = evalfr(G2, -0.218 + 4.78j)
K2_1 = -1/X2_1
Gcl2_1 = minreal(G2*abs(K2_1) / (1 + G2*abs(K2_1)))
roots([1 .4368 22.9])

% Cancel complex pole with zero
Gk2 = zpk([-.5],[-1.563],[7.5781]);
figure;
rlocus(Gk2)

% Add pole to cancel zero, add 0 pole for DC gain of 1
% Then add lead compensator zero to cancel pole of -1.563 and -4 to
 pull it
% back to meet timing
Gk2_2 = zpk([],[0, -4, -6],[7.5781]);
X2_2 = evalfr(Gk2_2, -1.1477 + 2.2355j)
K2_2 = -1/X2_2

Gcl2_2 = minreal(Gk2_2*abs(K2_2) / (1 + Gk2_2*abs(K2_2)))
roots([1 2.295 6.315])
figure;
step(Gcl2_2);


X2_1 =

 -26.3919 - 0.0147i


K2_1 =

   0.0379 - 0.0000i


Gcl2_1 =

           7.5781 (s+0.5)
  --------------------------------
  (s+1.563) (s^2 + 0.4368s + 22.9)

Continuous-time zero/pole/gain model.


ans =
```

```
  -0.2184 + 4.7804i
  -0.2184 - 4.7804i


X2_2 =

  -0.1558 - 0.0000i


K2_2 =

   6.4201 - 0.0001i


Gcl2_2 =

                48.652
  --------------------------------
  (s+7.705) (s^2 + 2.295s + 6.315)

Continuous-time zero/pole/gain model.


ans =

  -1.1475 + 2.2357i
  -1.1475 - 2.2357i
```


Root Locus
Imaginary Axis (seconds-1)
Real Axis (seconds-1)
20
15
10
5
0
-5
-10
-15
-20
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1


Root Locus
Imaginary Axis (seconds-1)
Real Axis (seconds-1)
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-1.5
-1
-0.5
0



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