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Controls Homework 10 Problem 1

```
Gs1 = zpk([],[2 -10 -15 -30],[200]);

X1 = evalfr(Gs1, -2)
K1 = -1/X1

Gcl1 = minreal(Gs1*abs(K1) / (1 + Gs1*abs(K1)))

Gs1_2 = zpk([],[0 -8 -20.24 -28.46],[11648]);

X1_2 = evalfr(Gs1_2, -2.3302 + 4.5505i)
K1_2 = -1/X1_2

Gcl1_2 = minreal(Gs1_2*abs(K1_2) / (1 + Gs1_2*abs(K1_2)))
roots([1 4.661 26.13])
figure;
step(Gcl1_2)
```

X1 =

 -0.0172

K1 =

 58.2400

Gcl1 =

```
                11648
  ---------------------------------
  (s+28.46) (s+20.24) (s+2.298) (s+2)
```

Continuous-time zero/pole/gain model.

X1_2 =

 -0.6394 + 0.0000i

```
K1_2 =

   1.5639 + 0.0000i


Gcl1_2 =

                     18216
   -----------------------------------------
   (s^2 + 52.04s + 697)(s^2 + 4.66s + 26.14)

Continuous-time zero/pole/gain model.


ans =

   -2.3305 + 4.5496i
   -2.3305 - 4.5496i
```

Step Response
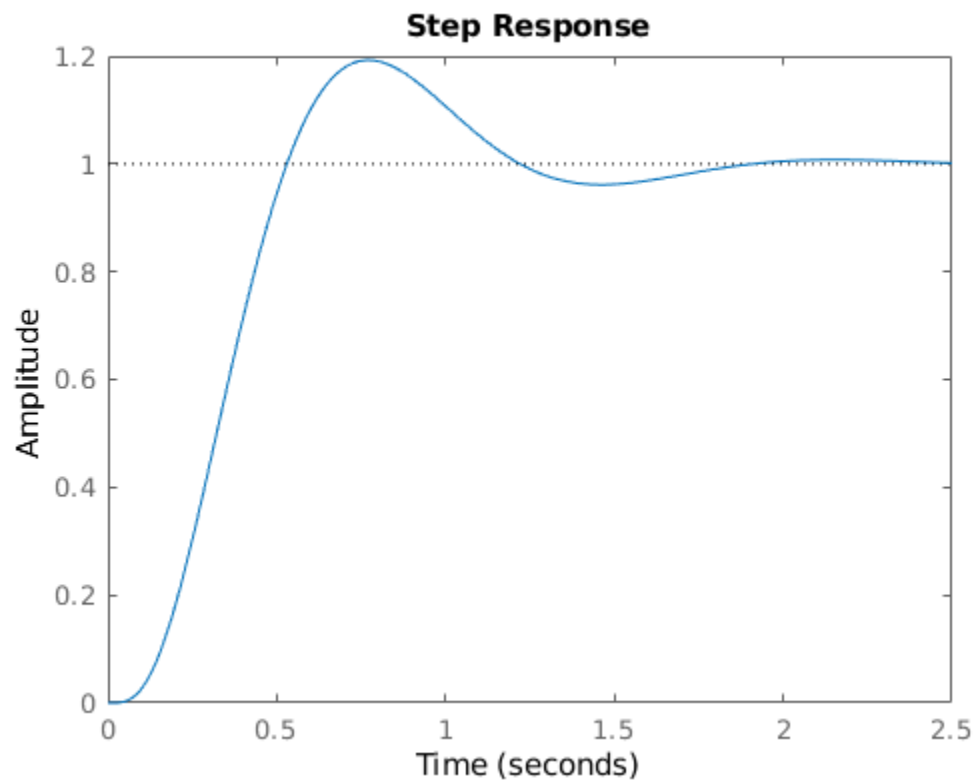
Controls Homework 10 Problem 2

```
T = .1;

s2 = [-2 -5 -10 -15];
```

```matlab
z2 = exp(s2*T);

Gz2 = zpk([],z2,1);
Gs2 = zpk([],s2,200);
kz2 = evalfr(Gz2, 1);
ks2 = evalfr(Gs2, 0);
k2 = ks2/kz2
Gz2 = zpk([0 0],z2,k2,T)
Gz2tf = tf(Gz2)

figure;
step(Gz2)
hold on
step(Gs2)
hold off
```

k2 =

    0.0047

Gz2 =

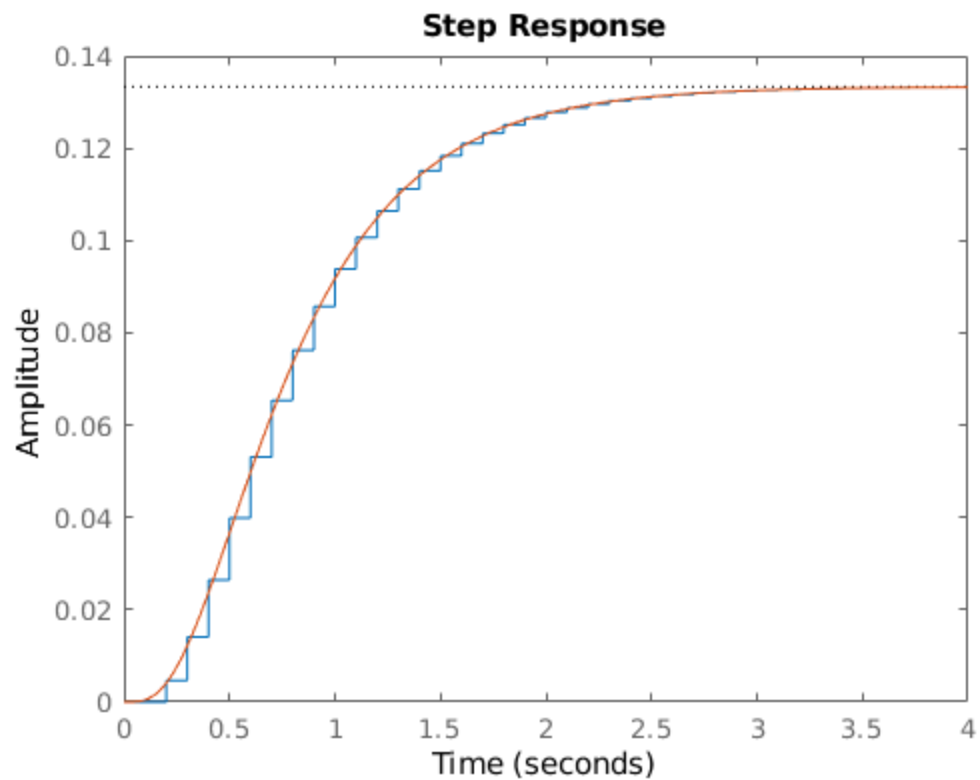$$\frac{0.0046701\ z^2}{(z-0.8187)\ (z-0.6065)\ (z-0.3679)\ (z-0.2231)}$$

Sample time: 0.1 seconds
Discrete-time zero/pole/gain model.

Gz2tf =

$$\frac{0.00467\ z^2}{z^4 - 2.016\ z^3 + 1.421\ z^2 - 0.4105\ z + 0.04076}$$

Sample time: 0.1 seconds
Discrete-time transfer function.

Step Response

Controls Homework 10 Problem 3

```
roots3 = roots([1 2 10]);
s3 = [roots3' -10];
z3 = exp(s3*T);

Gz3 = zpk([],z3,1);
Gs3 = zpk([],s3,200);
kz3 = evalfr(Gz3, 1);
ks3 = evalfr(Gs3, 0);
k3 = ks3/kz3
Gz3 = zpk([0 0],z3,k3,T)
Gz3tf = tf(Gz3)

figure;
step(Gz3)
hold on
step(Gs3)
hold off


k3 =

    0.1136
```
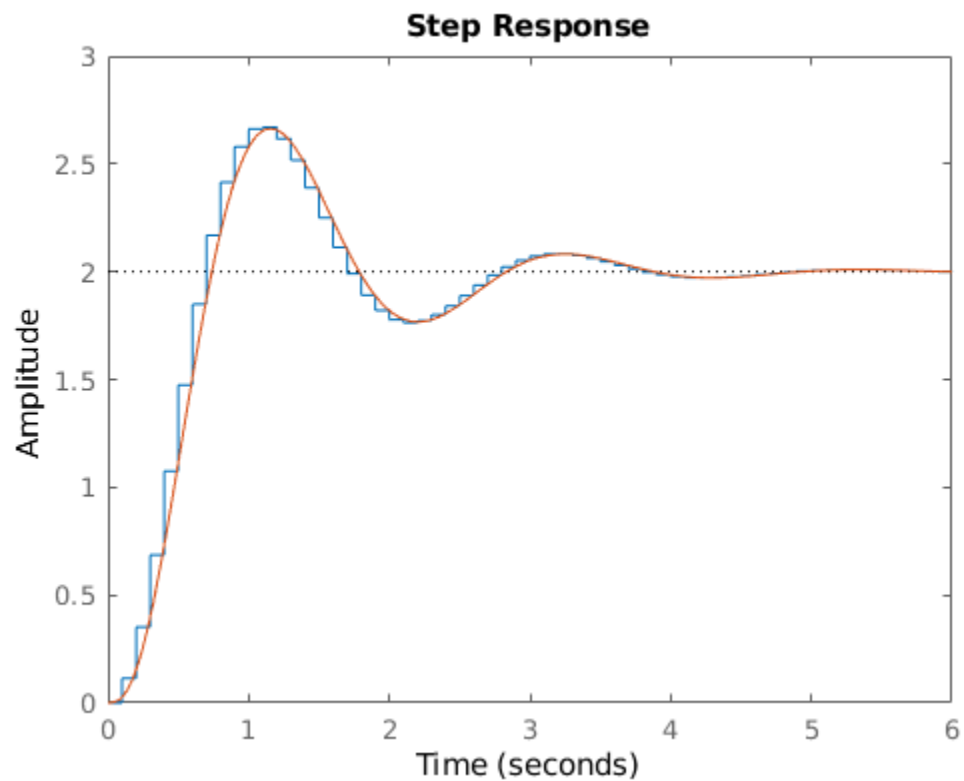
```
Gz3 =

            0.11363 z^2
   --------------------------------
   (z-0.3679) (z^2 - 1.729z + 0.8187)


Sample time: 0.1 seconds
Discrete-time zero/pole/gain model.


Gz3tf =

            0.1136 z^2
   --------------------------------
   z^3 - 2.097 z^2 + 1.455 z - 0.3012


Sample time: 0.1 seconds
Discrete-time transfer function.
```


Controls Homework 10 Problem 4

```
s4_poles = [0 -20];
z4_poles = exp(s4_poles*T);
s4_zeros = [-2 -5];
z4_zeros = exp(s4_zeros*T);
```

```matlab
Gz4 = zpk(z4_zeros,z4_poles,1);
Gs4 = zpk(s4_zeros,s4_poles,6);
kz4 = evalfr(Gz4, exp(0.01*T));
ks4 = evalfr(Gs4, 0.01);
k4 = ks4/kz4
Gz4 = zpk(z4_zeros,z4_poles,k4,T)
Gz4tf = tf(Gz4)

figure;
step(Gz4)
hold on
step(Gs4)
hold off
```
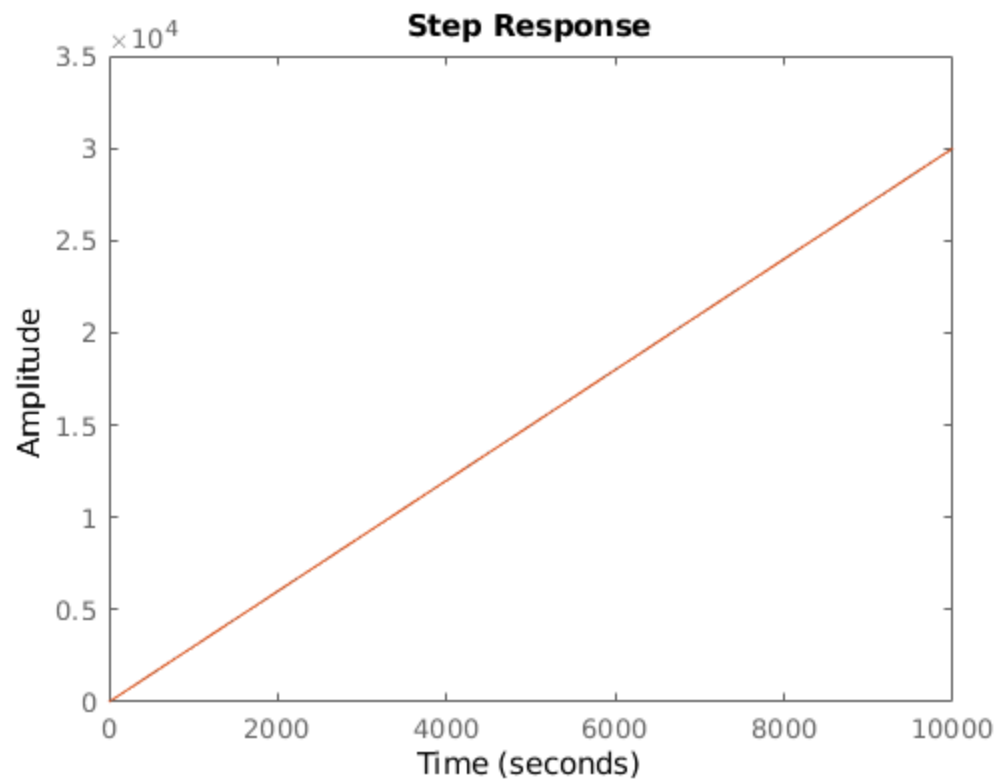
k4 =

*   3.6373*

Gz4 =

* 3.6373 (z-0.8187) (z-0.6065)*
* ---------------------------*
*   (z-1) (z-0.1353)*

Sample time: 0.1 seconds
Discrete-time zero/pole/gain model.

Gz4tf =

* 3.637 z^2 - 5.184 z + 1.806*
* ---------------------------*
*   z^2 - 1.135 z + 0.1353*

Sample time: 0.1 seconds
Discrete-time transfer function.

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