ECE414 Josh Andrews Homework #4

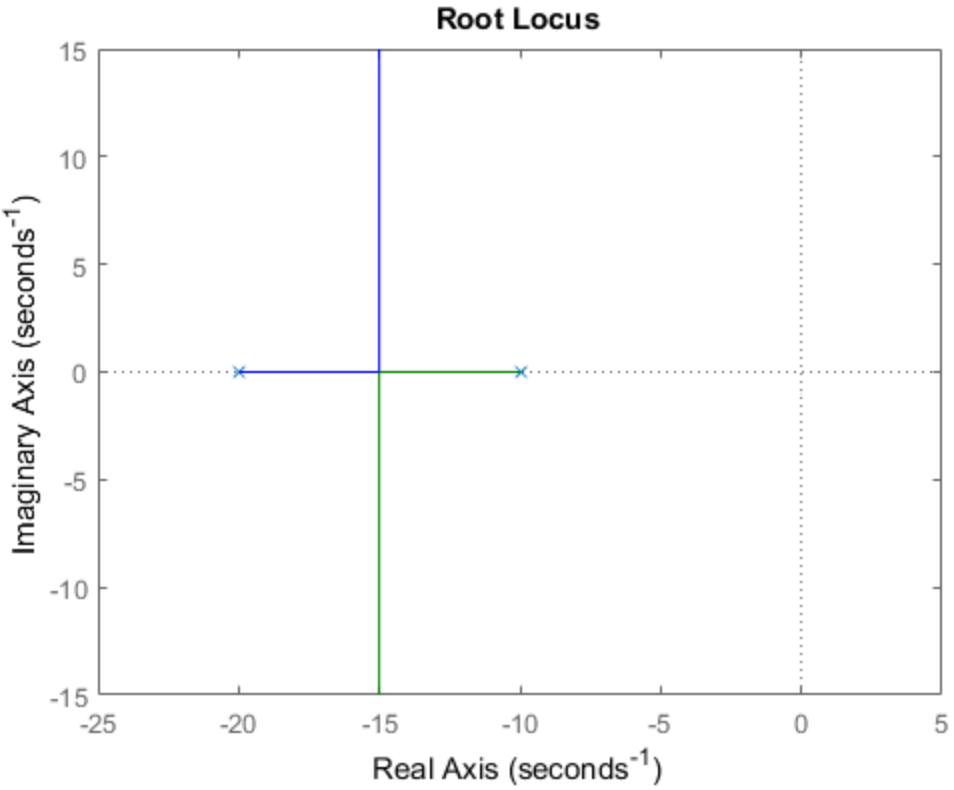
Table of Contents

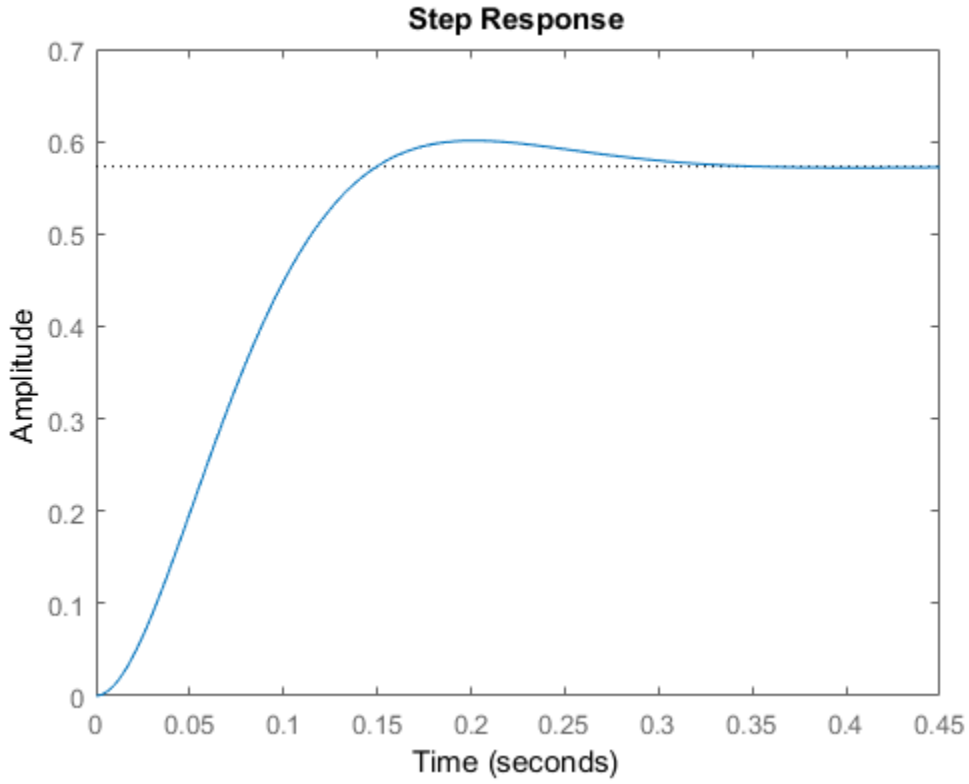
Question 1: Proportional Control 1
Question 2: Integral Control 3
Question 3: PI control, Z = 5 4
Question 4: PI control, Z = 15 6
Question 5: PI control, Z = 30 7
Which is Best 9
Question 6, PID control 9

Question 1: Proportional Control

The best value of K to minimize settling time while keeping %OS < 5 is 6.71, found by trying various values of K

```
clear all; clc;
k = 6.71;

s = tf('s');
H = (40*k)/((s+10)*(s+20));
T = feedback(ss(H),1);
Data = rlocusdata(H);
figure(1);
rlocus(H)
figure(2);
step(T)
```

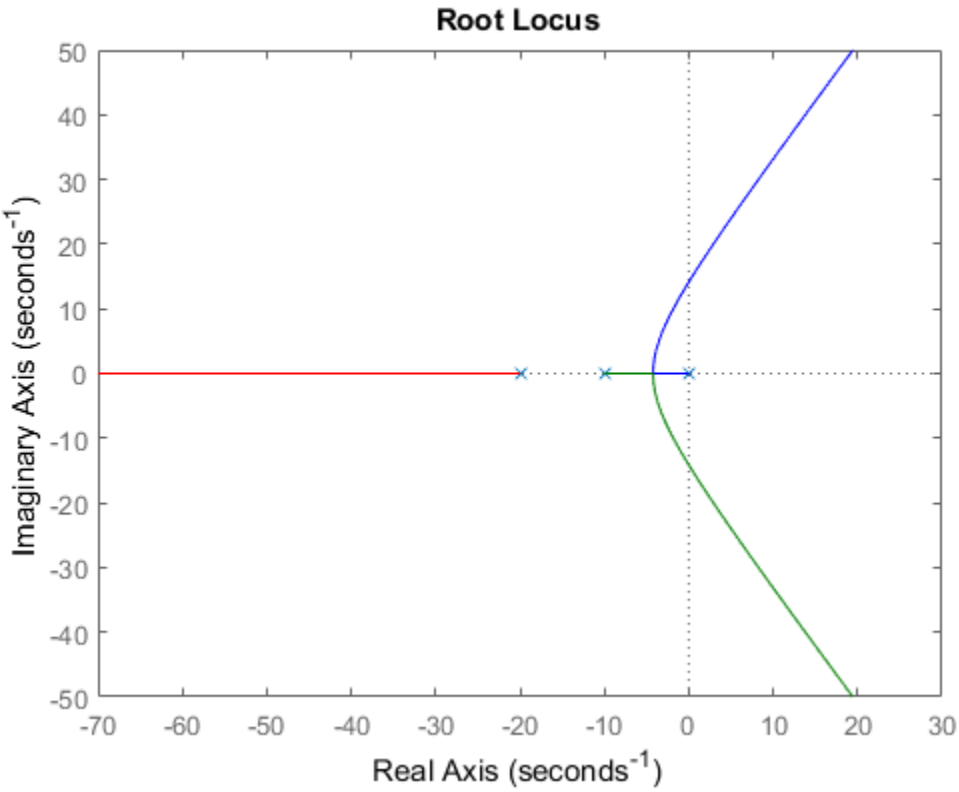

Root Locus
Imaginary Axis (seconds-1)
Real Axis (seconds-1)
15
10
5
0
-5
-10
-15
-25
-20
-15
-10
-5
0
5

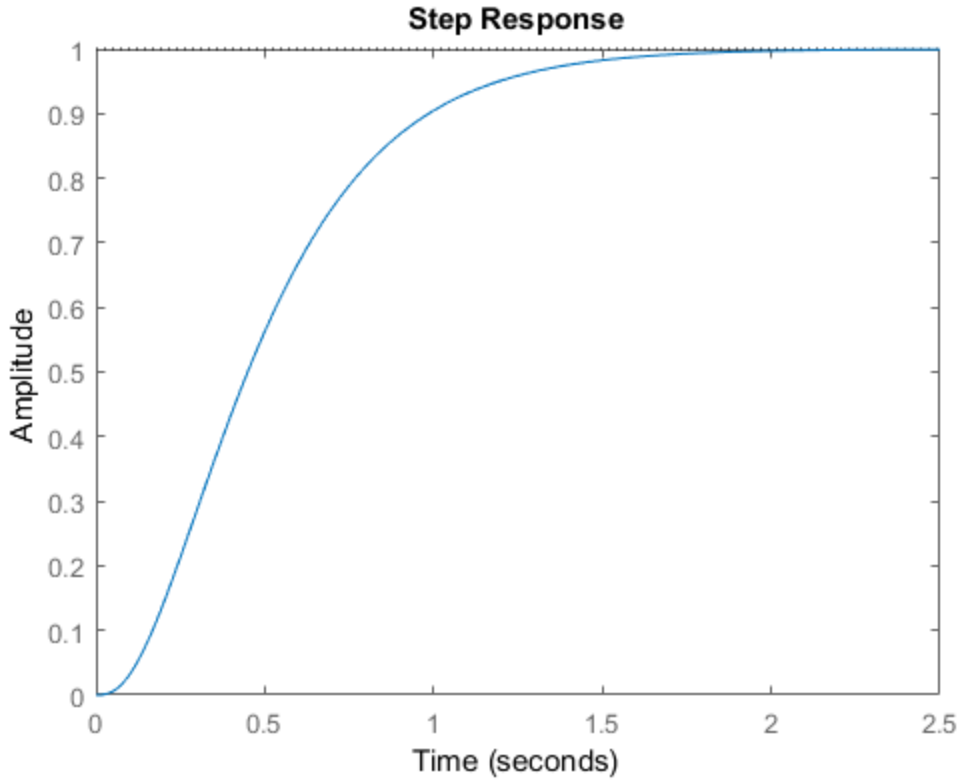

Step Response
Amplitude
Time (seconds)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45

Question 2: Integral Control

The best value of K to minimize settling time while keeping %OS < 5 is 9.5, found by trying various values of K

```
k=9.5;

H = (40*k)/(s*(s+10)*(s+20));
T = feedback(ss(H),1);
b = rlocusdata(H);
figure(3);
rlocus(H)
figure(4);
step(T)
```

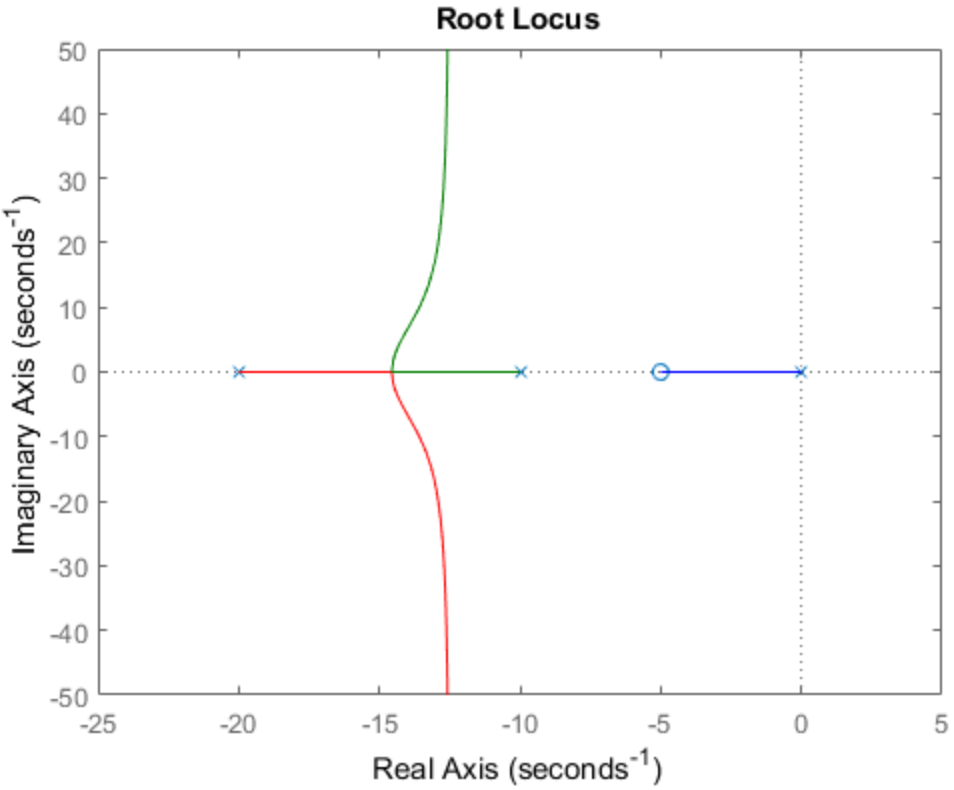


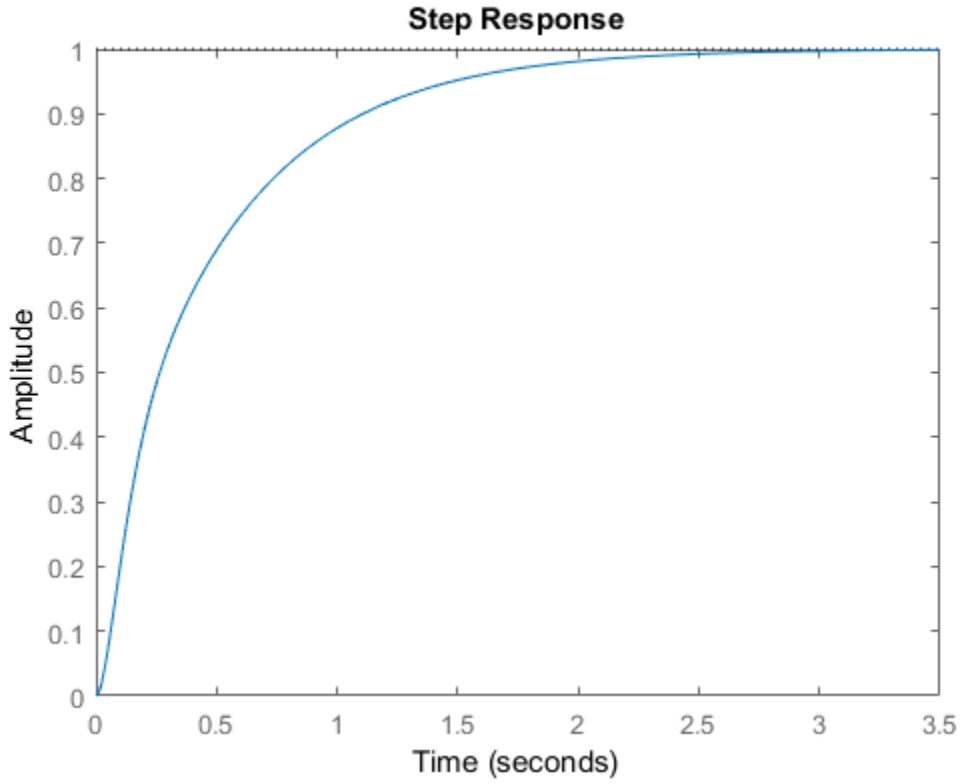


Question 3: PI control, Z = 5

The best value of K to minimize settling time while keeping %OS < 5 is 2.2, found by trying various values of K

```
k=2.2;
H = ((40*k)*(s+5))/(s*(s+10)*(s+20));
T = feedback(ss(H),1);
b = rlocusdata(H);
figure(5);
rlocus(H)
figure(6);
step(T)
```

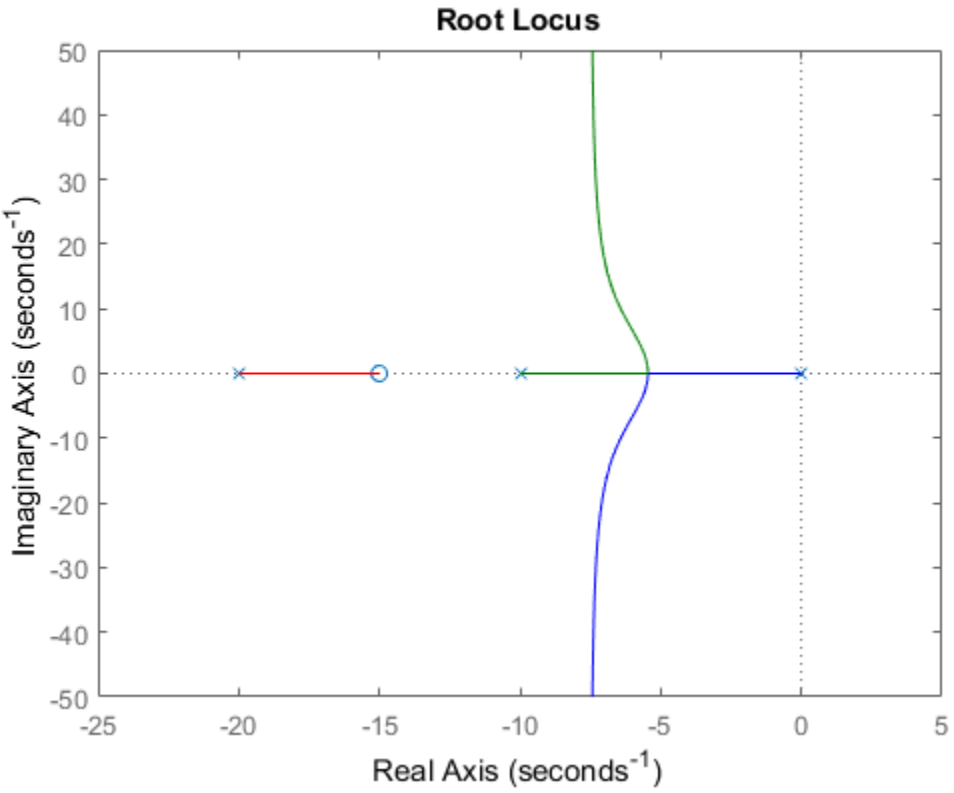

Root Locus
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})
50
40
30
20
10
0
-10
-20
-30
-40
-50
-25
-20
-15
-10
-5
0
5

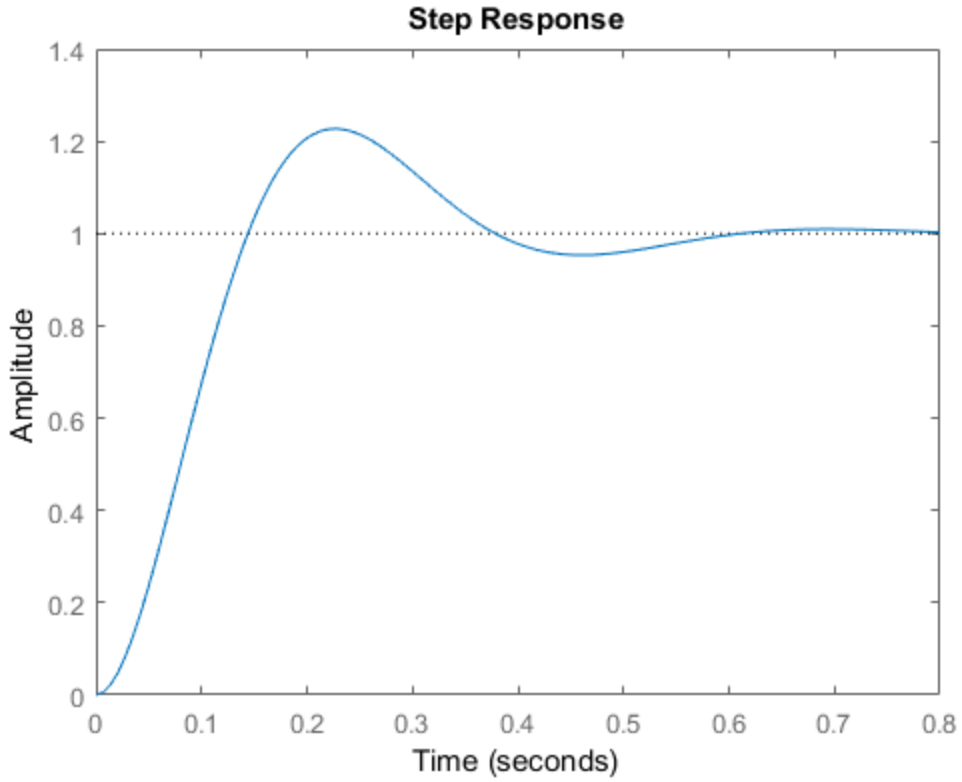

Step Response
Amplitude
Time (seconds)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
2.5
3
3.5

Question 4: PI control, Z = 15

The best value of K to minimize settling time while keeping %OS < 5 is 6.25, found by trying various values of K

```
k=6.25;
H = ((40*k)*(s+15))/(s*(s+10)*(s+20));
T = feedback(ss(H),1);
b = rlocusdata(H);
figure(7);
rlocus(H)
figure(8);
step(T)
```

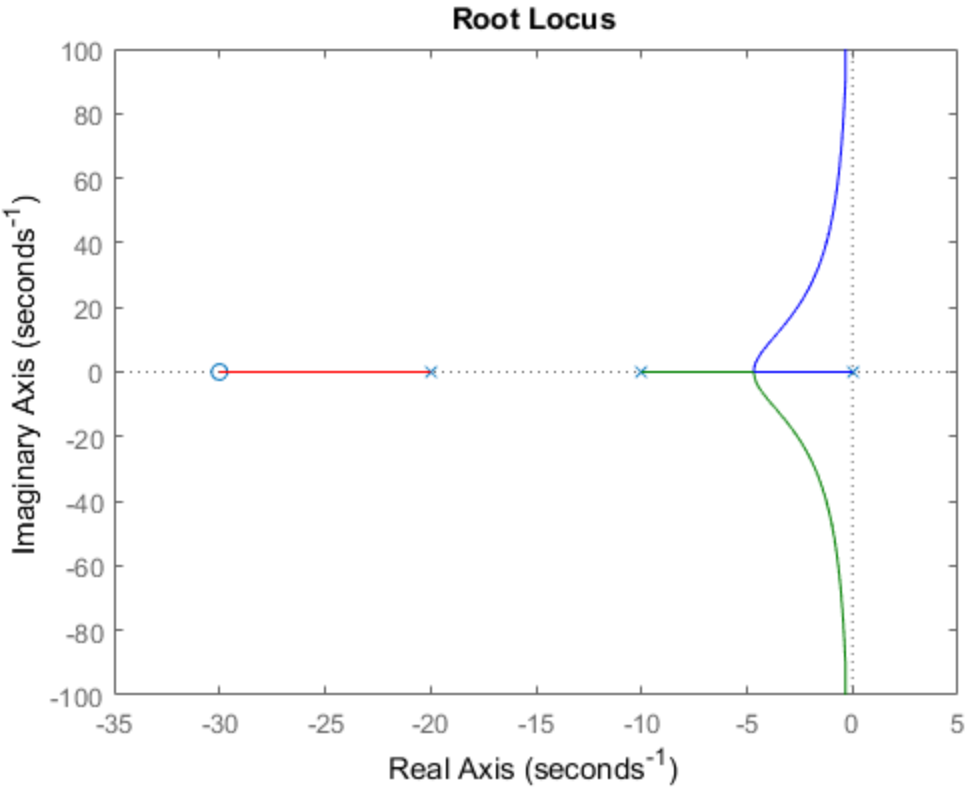


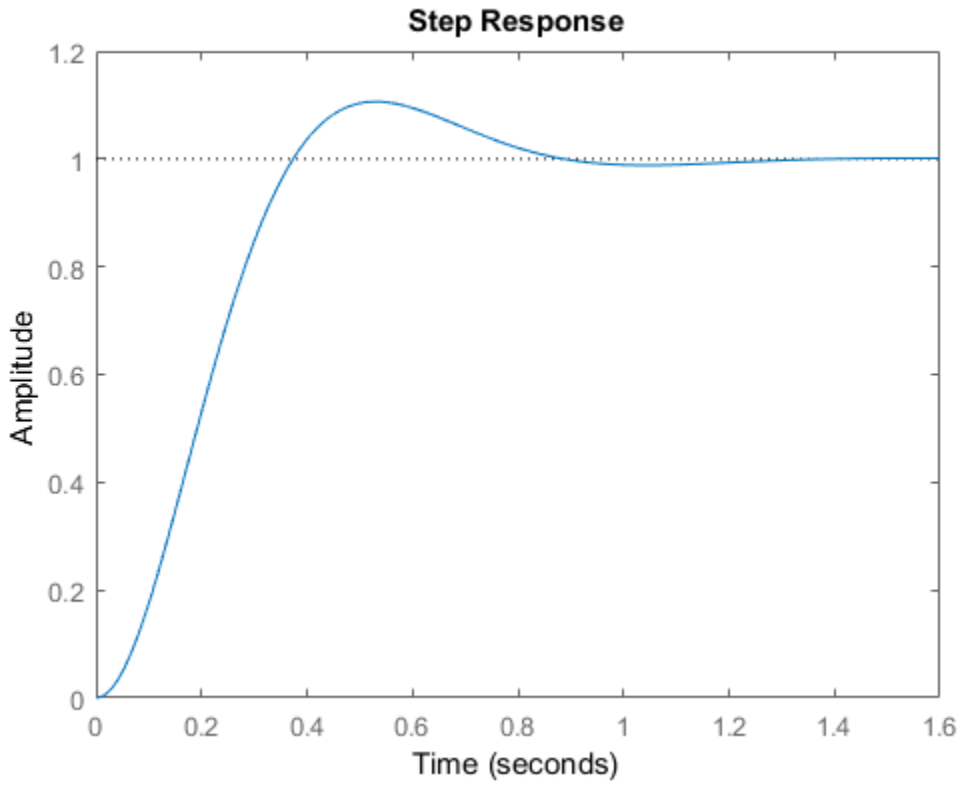


Question 5: PI control, Z = 30

The best value of K to minimize settling time while keeping %OS < 5 is 1, found by trying various values of K

```
k=1;
H = ((40*k)*(s+30))/(s*(s+10)*(s+20));
T = feedback(ss(H),1);
b = rlocusdata(H);
figure(9);
rlocus(H)
figure(10);
step(T)
```


Root Locus
Imaginary Axis (seconds-1)
Real Axis (seconds-1)
100
80
60
40
20
0
-20
-40
-60
-80
-100
-35
-30
-25
-20
-15
-10
-5
0
5

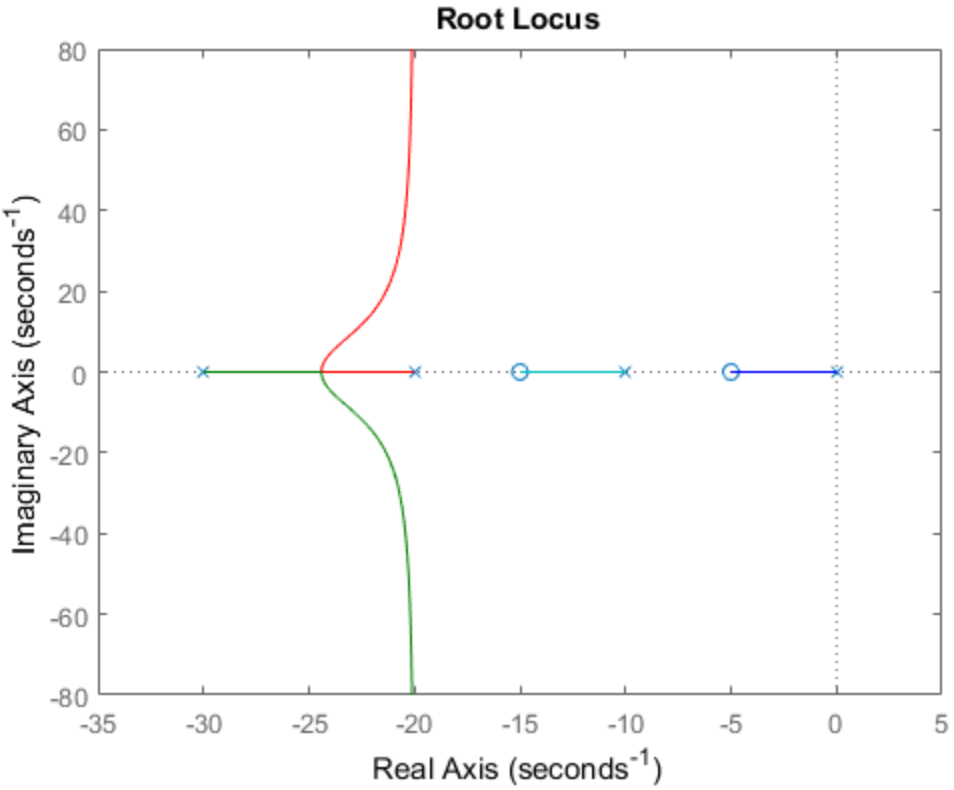

Step Response
Amplitude
Time (seconds)
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6

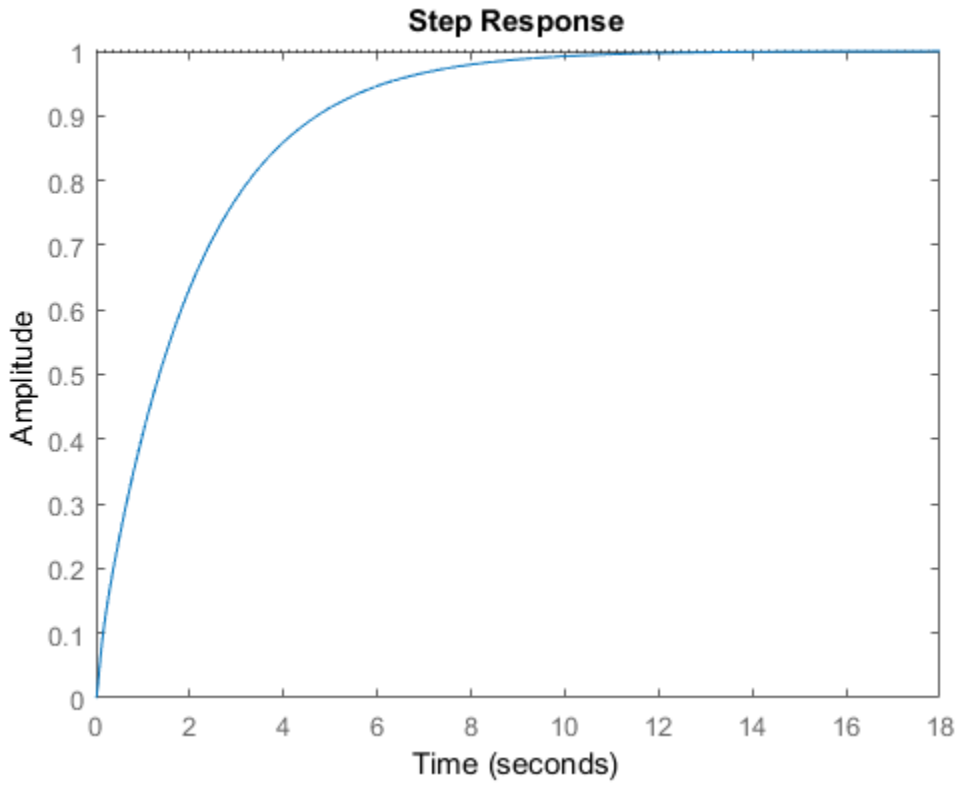
Which is Best

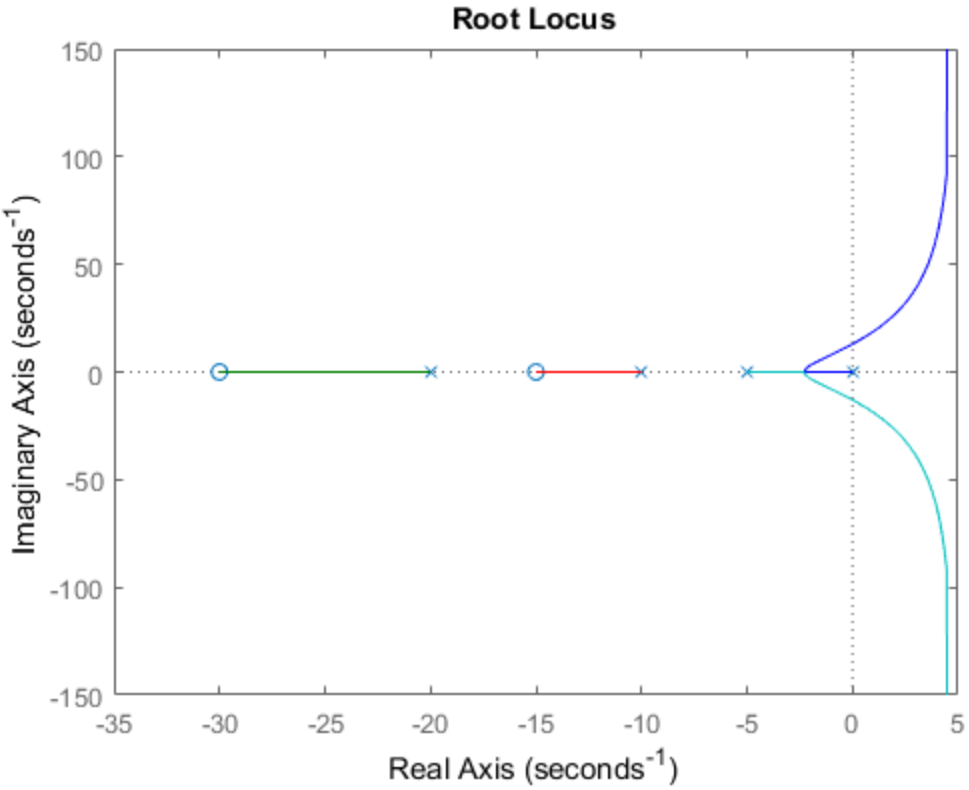
The best system is hard to define as system applications vary. I would choose would be the PI controller with Z = 15. While the system has a larger %OS than others, it has one of the fastest rise times and settling times

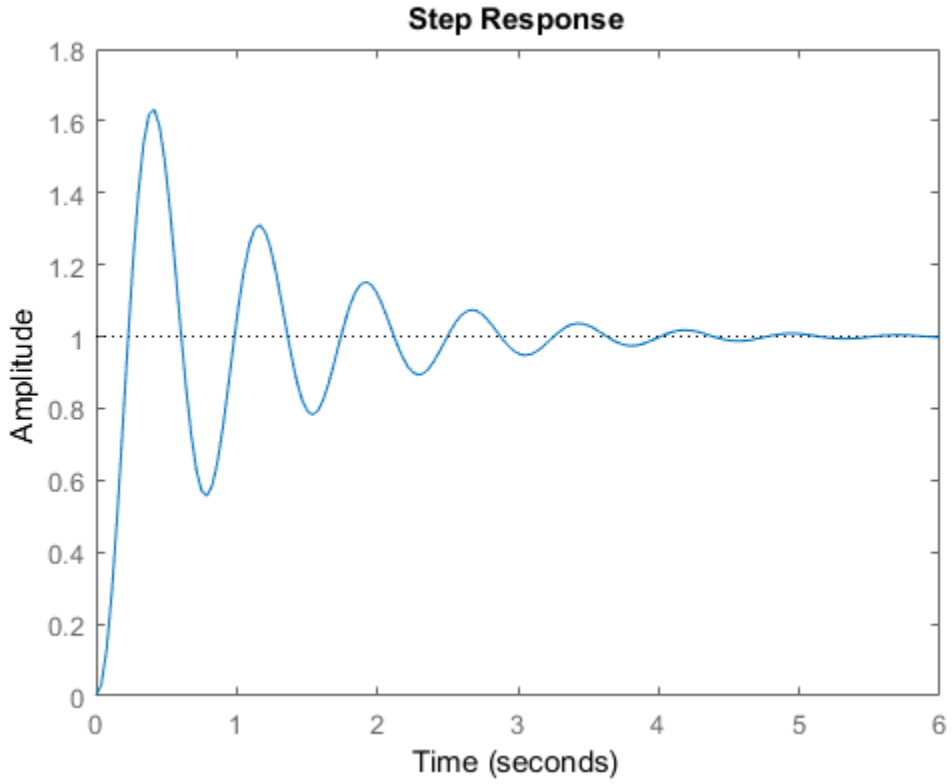
Question 6, PID control

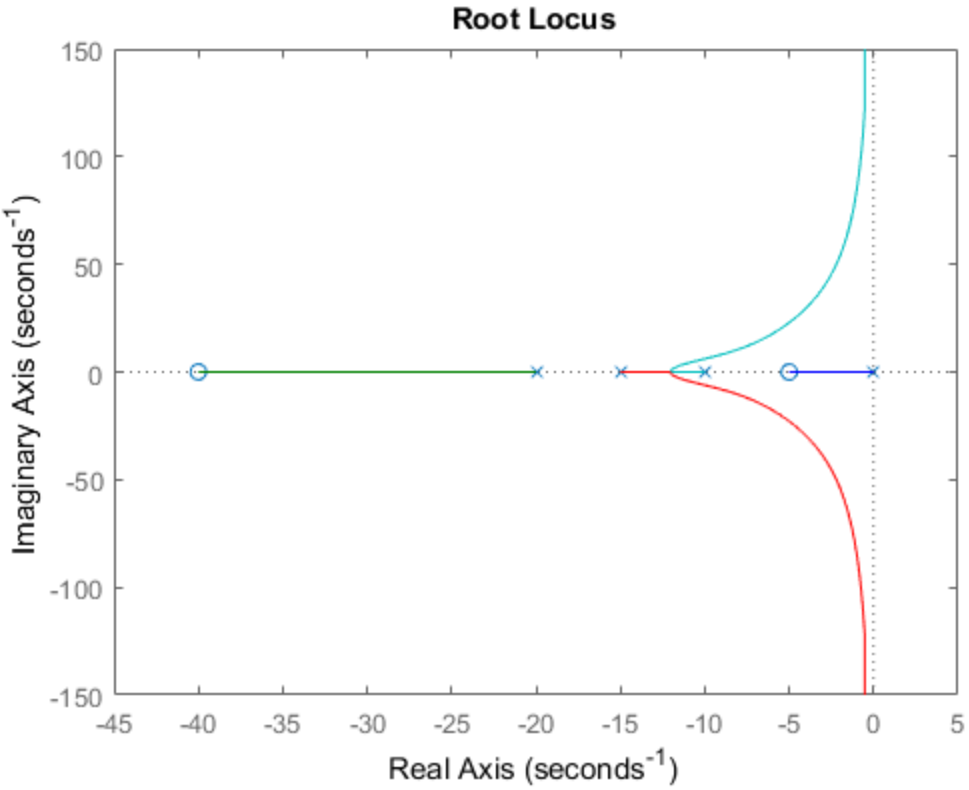
```
k = 1;

% test 1 values
z1 = 5;
z2 = 15;
p = 30;

H = ((40*k)*(s+z1)*(s+z2))/(s*(s+10)*(s+20)*(s+p));
T = feedback(ss(H),1);
b = rlocusdata(H);
figure(11);
rlocus(H)
figure(12);
step(T)

% test 2 values
z1 = 30;
z2 = 15;
p = 5;

H = ((40*k)*(s+z1)*(s+z2))/(s*(s+10)*(s+20)*(s+p));
T = feedback(ss(H),1);
b = rlocusdata(H);
figure(13);
rlocus(H)
figure(14);
step(T)

% test 3 values
z1 = 40;
z2 = 5;
p = 15;

H = ((40*k)*(s+z1)*(s+z2))/(s*(s+10)*(s+20)*(s+p));
T = feedback(ss(H),1);
b = rlocusdata(H);
figure(15);
rlocus(H)
figure(16);
step(T)
```

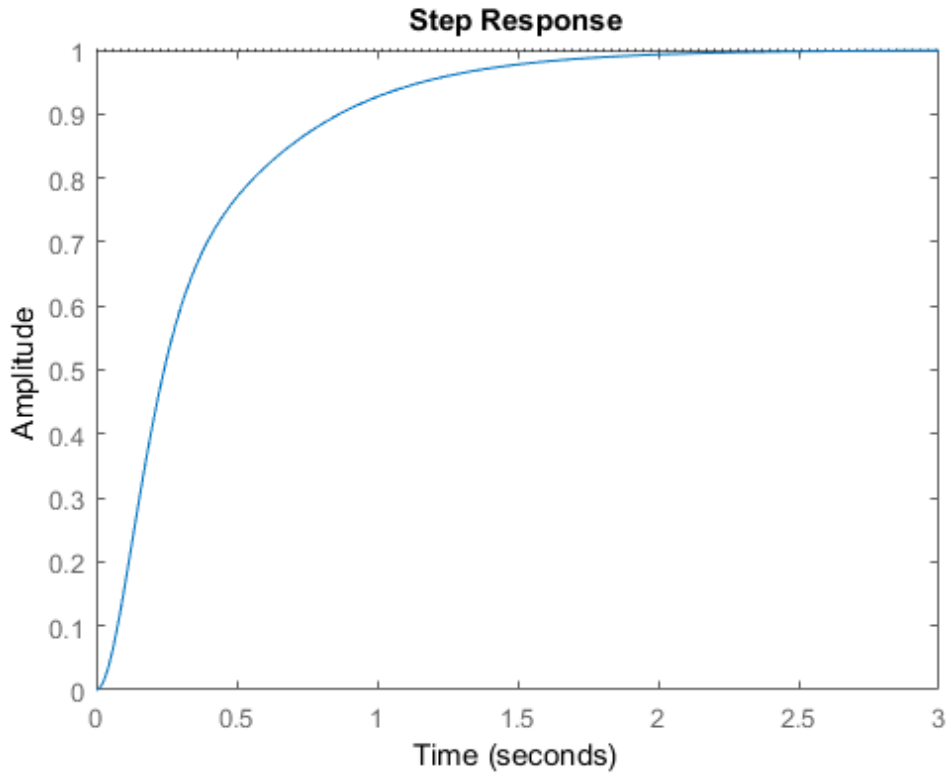

Root Locus
Imaginary Axis (seconds^{-1})
Real Axis (seconds^{-1})
80
60
40
20
0
-20
-40
-60
-80
-35
-30
-25
-20
-15
-10
-5
0
5


Step Response
Amplitude
Time (seconds)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
14
16
18


Root Locus
Imaginary Axis (seconds-1)
Real Axis (seconds-1)
150
100
50
0
-50
-100
-150
-35
-30
-25
-20
-15
-10
-5
0
5


Step Response
Amplitude
Time (seconds)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
1
2
3
4
5
6


Root Locus
Imaginary Axis (seconds-1)
Real Axis (seconds-1)
150
100
50
0
-50
-100
-150
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5


Step Response
Amplitude
Time (seconds)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.5
1
1.5
2
2.5
3

Published with MATLAB® R2017a