Experiment 8.1

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Objectives

To verify the effect of open-loop poles and zeros upon the shape of the root locus. To verify the root locus as a tool for estimating the effect of open-loop gain upon the transient response of closed-loop systems.

Minimum Required Software Packages

MATLAB, Simulink, and the Control System Toolbox.

Prelab

Problem 1

Sketch two possibilities for the root locus of a unity negative-feedback system with the open-loop pole-zero configuration shown in Figure P8.21

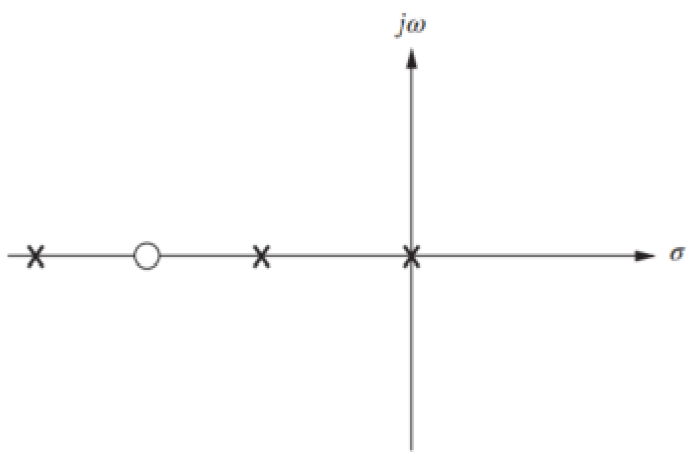


FIGURE P8.21

Answer:

Problem 2

If the open-loop system of Prelab 1 is $G(s) = \frac{K(s+1.5)}{s(s+0.5)(s+10)}$, estimate the precent overshoot at the following values of gain, $K: 20, 50, 85, 200, 700$.

Answer:

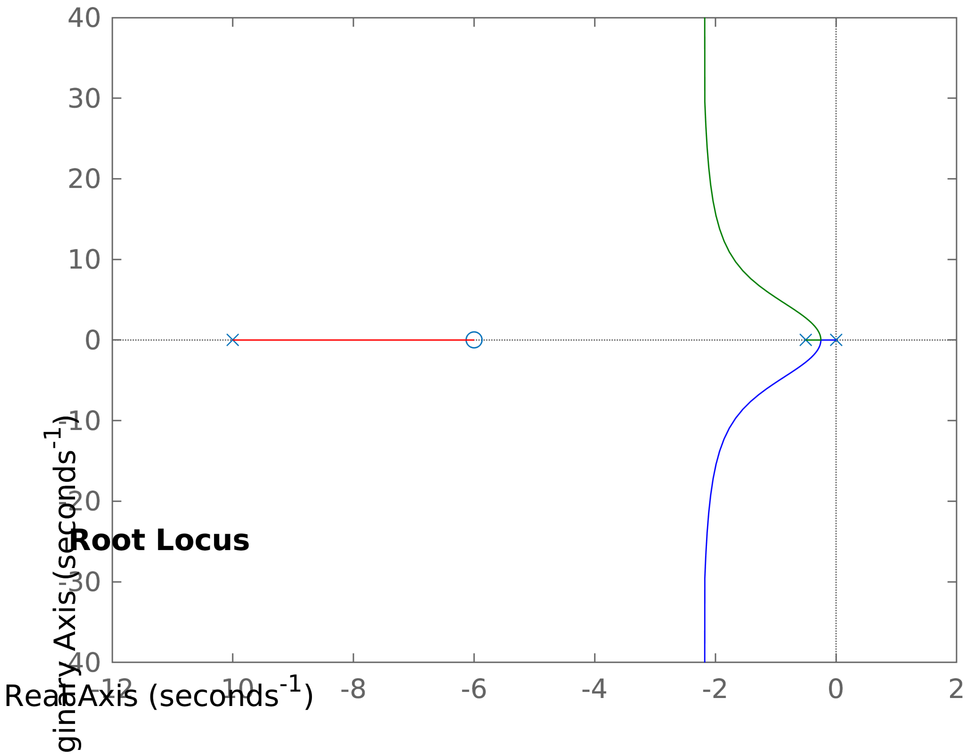
$K=20, %O.S.=

Lab

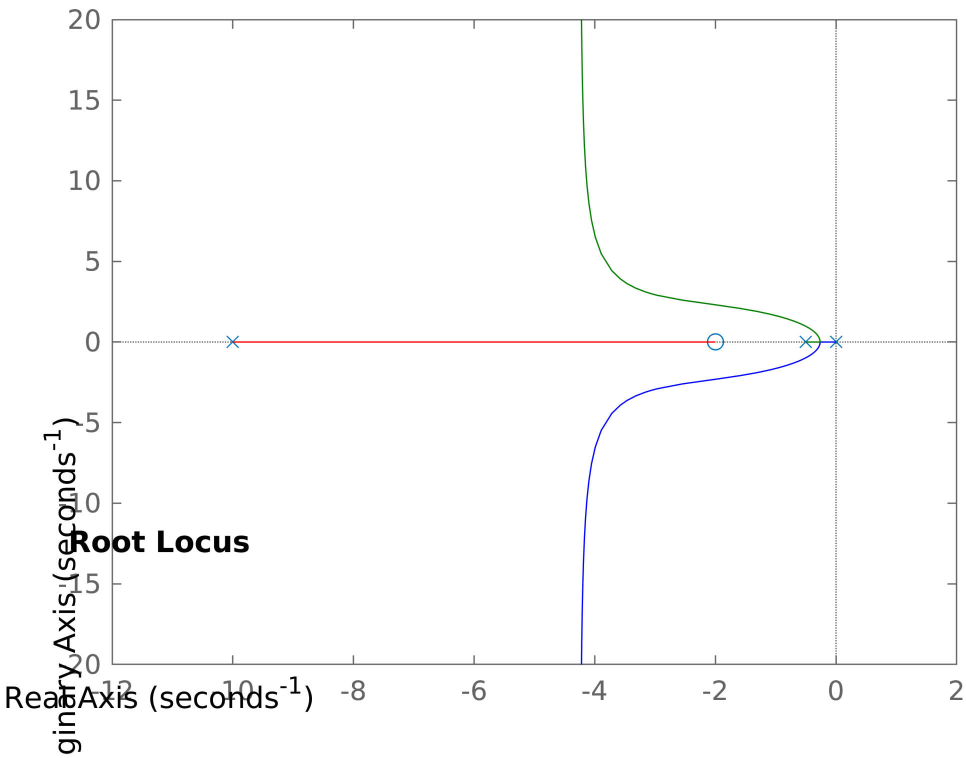
Problem 1

Using MATLAB's SISO Design Tool, set up a negative unity feedback system with $G(s) = \frac{K(s+6)}{s(s+0.5)(s+10)}$ *to produce a root locus. For convenience, set up the zero at* �6 *using SISO Design Tool's compensator function by simply dragging a zero to -*�6 *on the resulting root locus. Print the root locus for the zero* at� *-6. Move the zero to the following locations and print out a root locus at each location: -*�2, *-1.5, -1.37, and -1.2.*

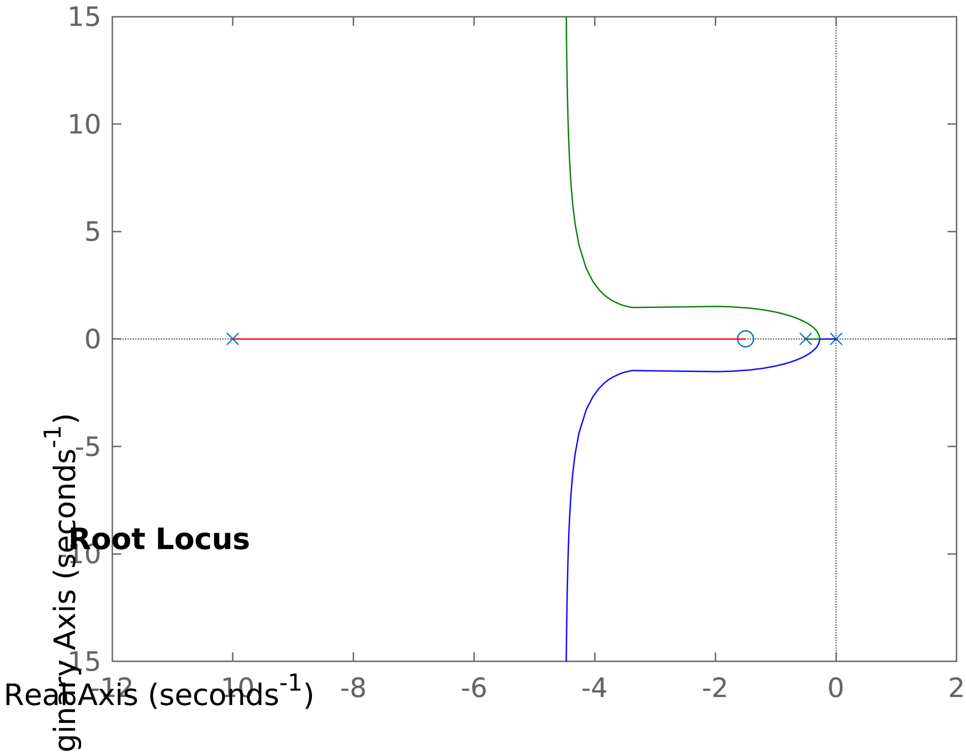
```
rlocus(p1_6)
```


Root Locus
Real Axis (seconds^{-1})
ginary Axis (seconds^{-1})
40
30
20
10
0
-10
-20
-30
-40
-12
-10
-8
-6
-4
-2
0
2

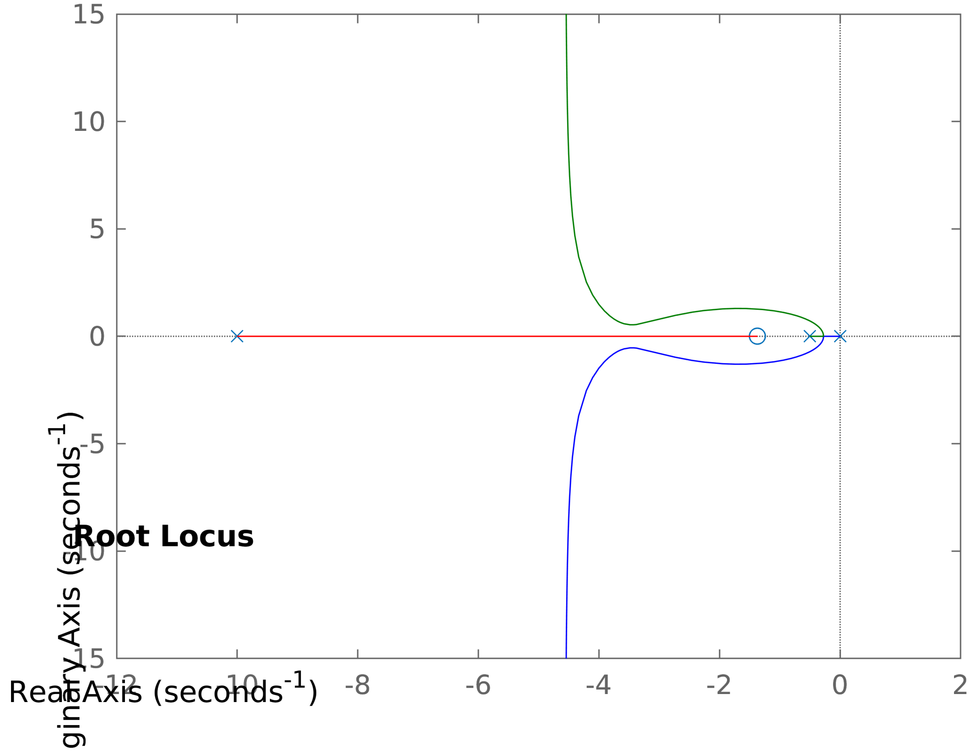
```
rlocus(p1_2)
```


Root Locus
Real Axis (seconds^{-1})
ginary Axis (seconds^{-1})
20
15
10
5
0
-5
-10
-15
-20
-12
-10
-8
-6
-4
-2
0
2

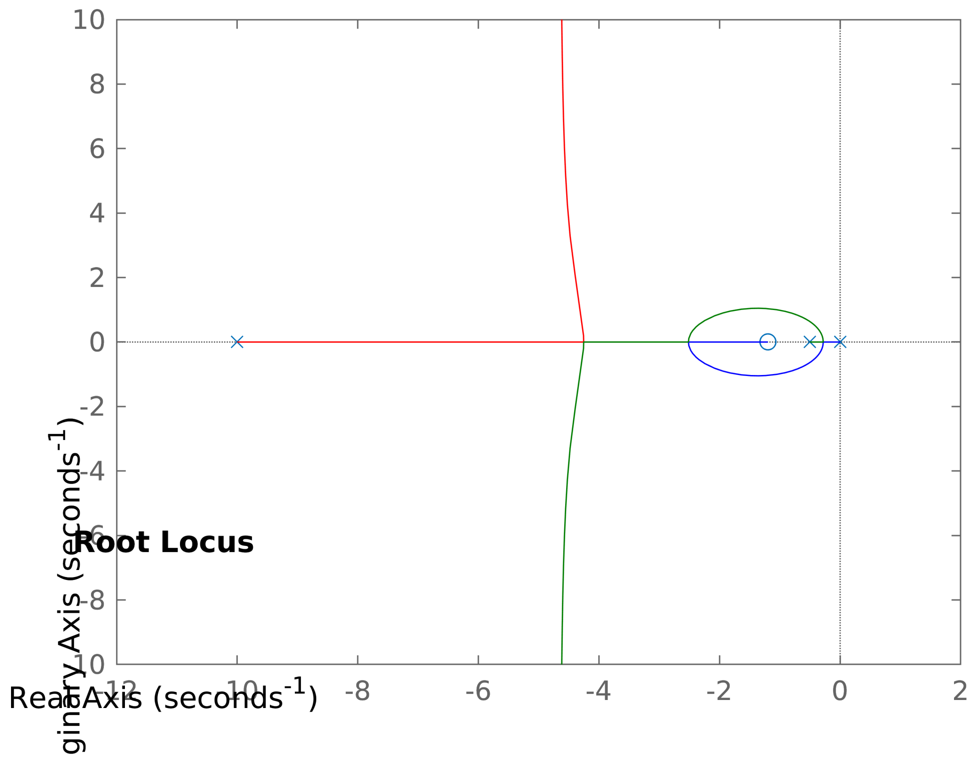
```
rlocus(p1_1_5)
```




```
rlocus(p1_1_37)
```


Root Locus
Imaginary Axis (seconds^-1)
Real Axis (seconds^-1)
15
10
5
0
-5
-10
-15
-12
-10
-8
-6
-4
-2
0
2

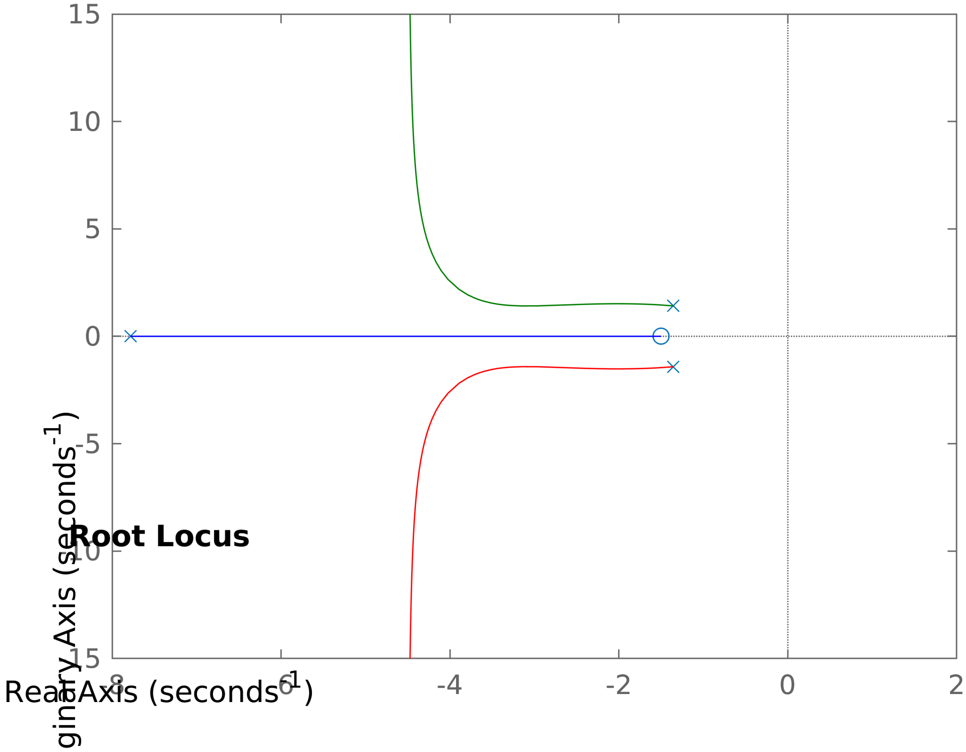
```
rlocus(p1_1_2)
```


Root Locus
Imaginary Axis (seconds^-1)
Real Axis (seconds^-1)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-10
-8
-6
-4
-2
0
2

Problem 2

Using MATLAB's SISO Design Tool, set up a negative unity feedback system with $G(s) = \dfrac{K(s+1.5)}{s(s+0.5)(s+10)}$ *to produce a root locus. Open the LTI Viewer for SISO Design Tool to show step responses. Using the values of K specified in Prelab 2, record the percent overshoot and settling time and print the root loci and step response for each value of K.*

```
rlocus(p2_20)
```




```
stepinfo(p2_20)
```

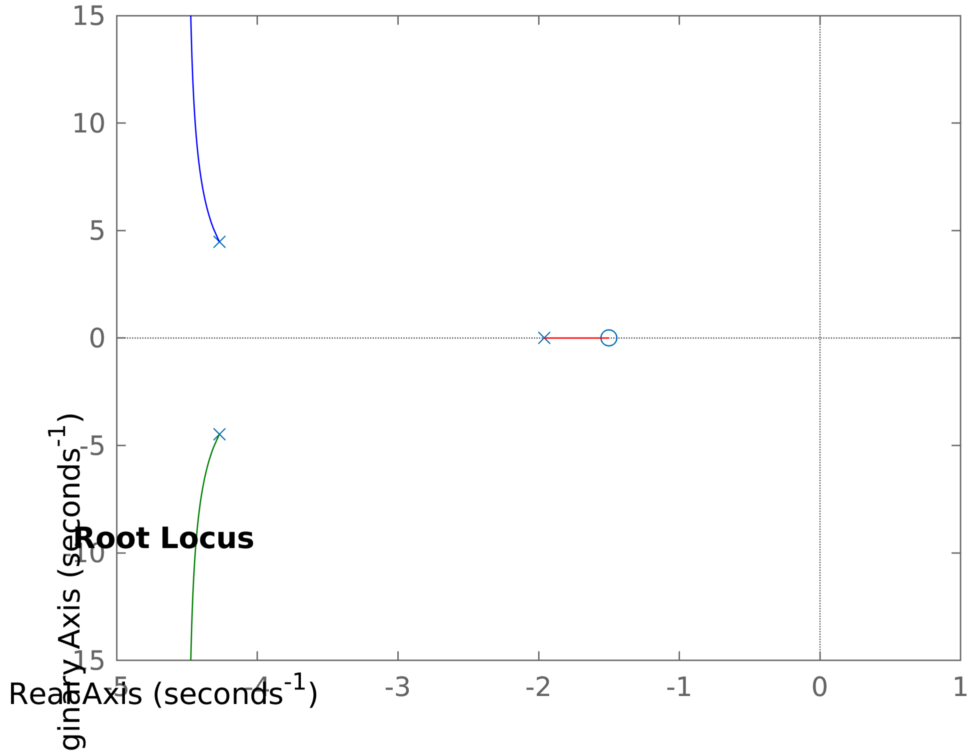
```
ans = struct with fields:
        RiseTime: 0.5314
    SettlingTime: 2.6390
     SettlingMin: 0.9010
     SettlingMax: 1.1841
       Overshoot: 18.4064
      Undershoot: 0
            Peak: 1.1841
        PeakTime: 1.3372
```

```
stepinfo(p2_50)
```

```
ans = struct with fields:
        RiseTime: 0.2522
    SettlingTime: 1.5399
     SettlingMin: 0.9031
     SettlingMax: 1.2037
```

```
      Overshoot: 20.3710
     Undershoot: 0
           Peak: 1.2037
       PeakTime: 0.6040
```

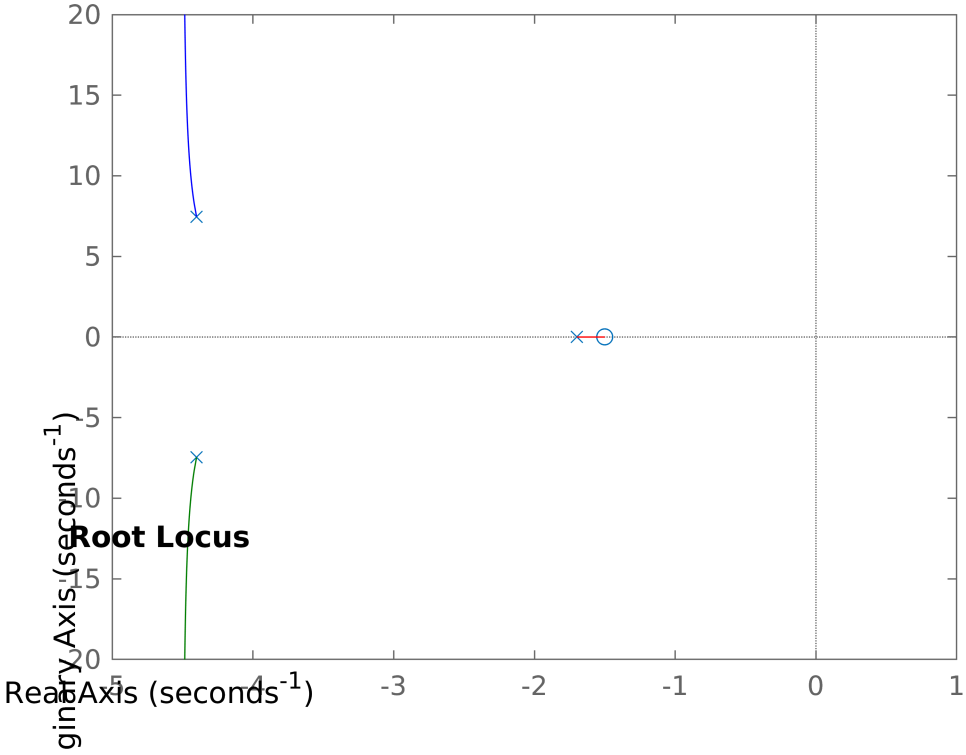
```
rlocus(p2_50)
```




```
stepinfo(p2_85)
```

```
ans = struct with fields:
       RiseTime: 0.1695
   SettlingTime: 1.3368
    SettlingMin: 0.9362
    SettlingMax: 1.2593
      Overshoot: 25.9262
     Undershoot: 0
           Peak: 1.2593
       PeakTime: 0.4186
```

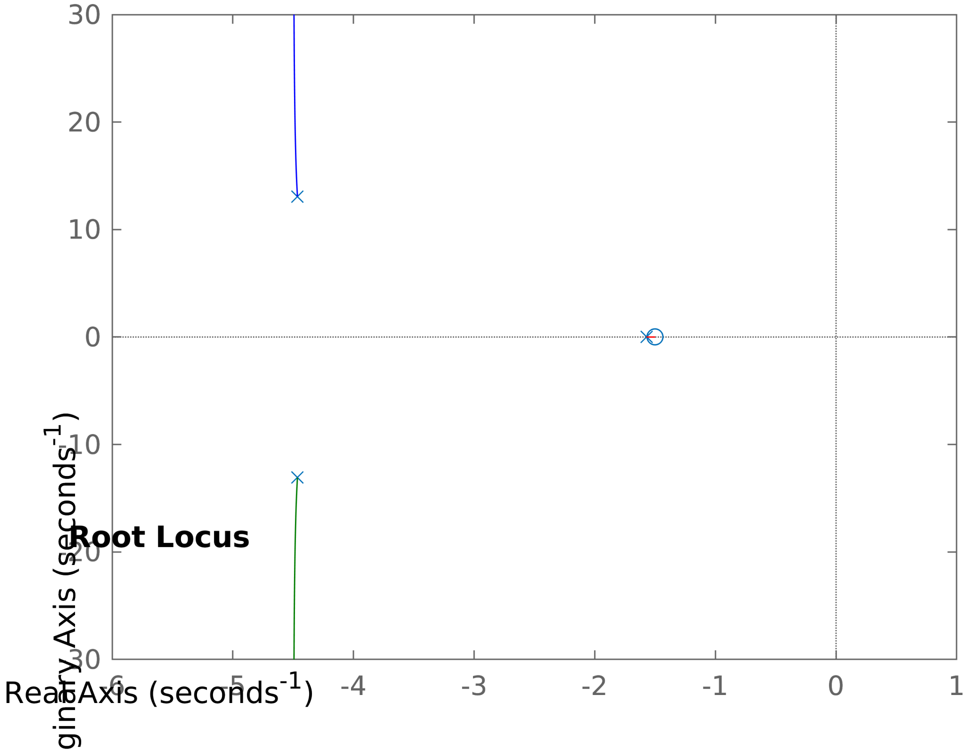
```
rlocus(p2_85)
```




```
stepinfo(p2_200)
```

```
ans = struct with fields:
        RiseTime: 0.0943
    SettlingTime: 0.8453
     SettlingMin: 0.9008
     SettlingMax: 1.3938
       Overshoot: 39.3819
      Undershoot: 0
            Peak: 1.3938
        PeakTime: 0.2372
```

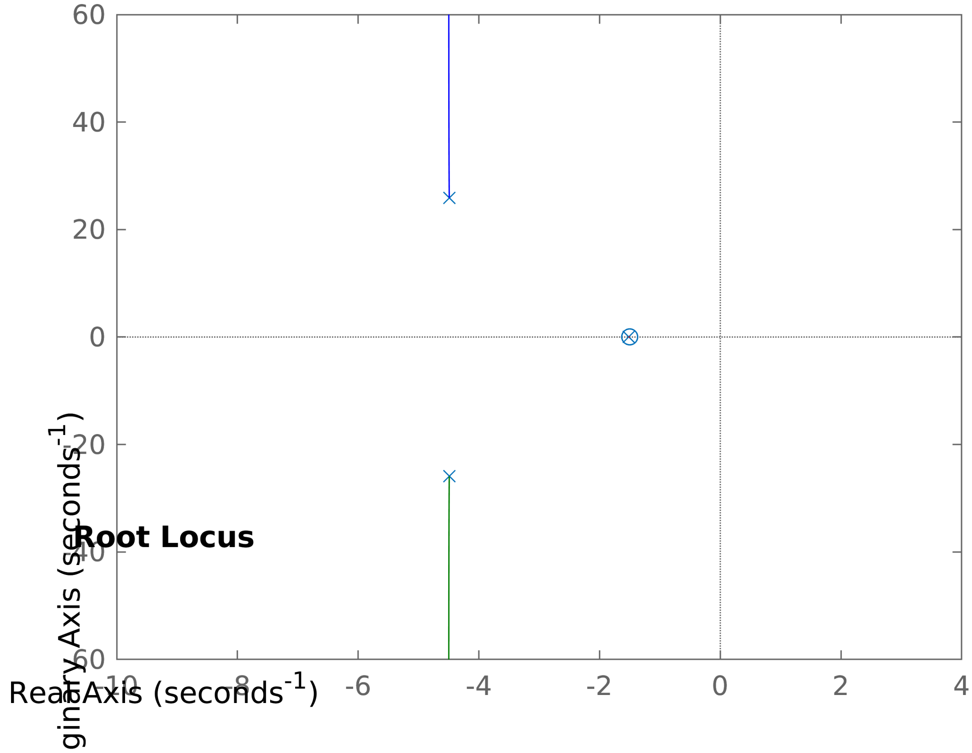
```
rlocus(p2_200)
```




```
stepinfo(p2_700)
```

```
ans = struct with fields:
        RiseTime: 0.0448
    SettlingTime: 0.8776
     SettlingMin: 0.6695
     SettlingMax: 1.5973
       Overshoot: 59.7344
      Undershoot: 0
            Peak: 1.5973
        PeakTime: 0.1231
```

```
rlocus(p2_700)
```



Postlab

Problem 1

Discuss your findings from Prelab 1 and Lab 1. What conclusions can you draw?

Problem 2

Make a table comparing percent overshoot and settling time from your calculations in Prelab 2 and your experimental values found in Lab 2. Discuss the reasons for any discrepancies. What conclustions can you draw?