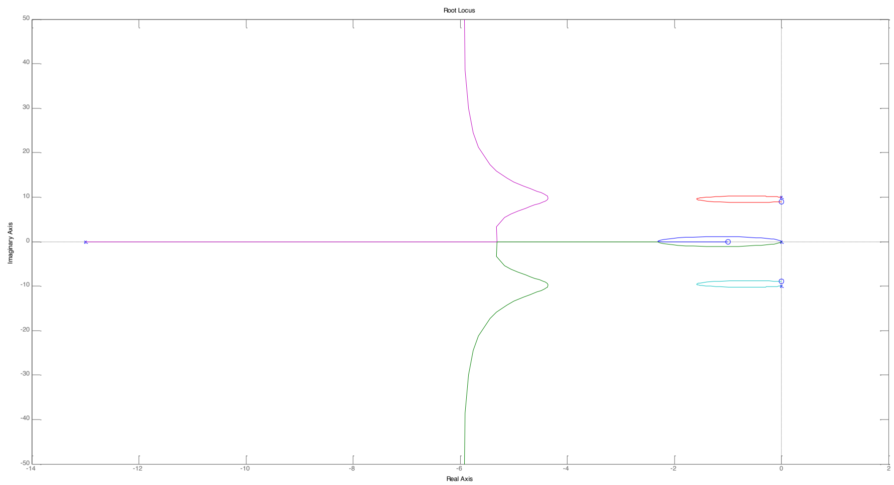
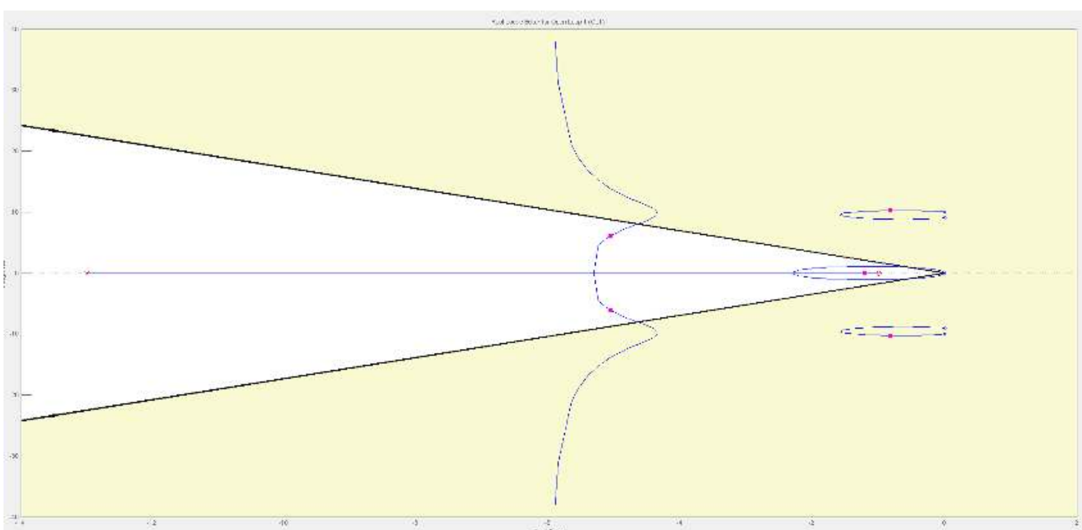
Mae 143b Hw 7 Solutions

Problem 5.13)

Part a) Open Loop Root locus for the system

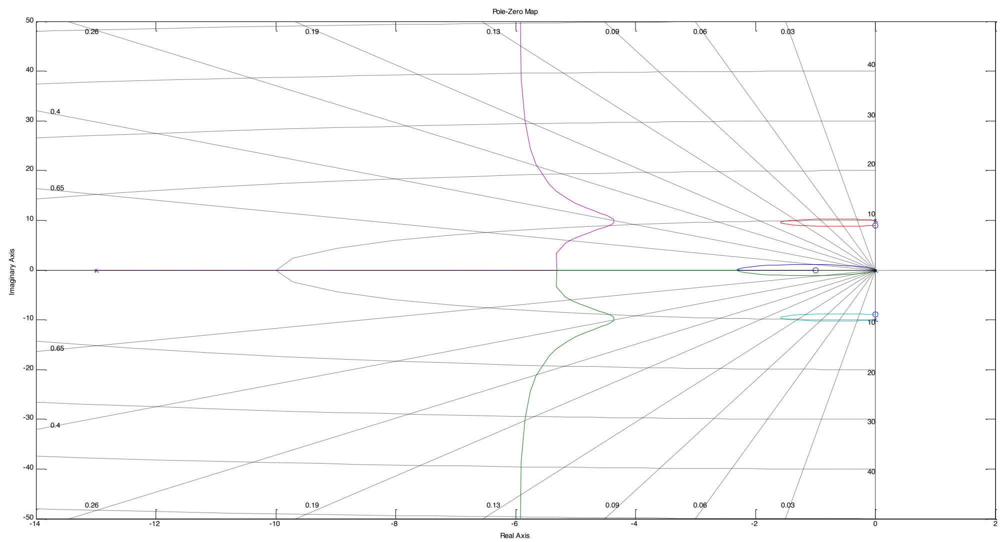


Part b) No there is not. From drawing the design criteria we know we need our poles to fall in the white area of the plot below (plot found using SISOTOOL command in matlab). This comes from ø = sin^{-1}(ζ) = 30°



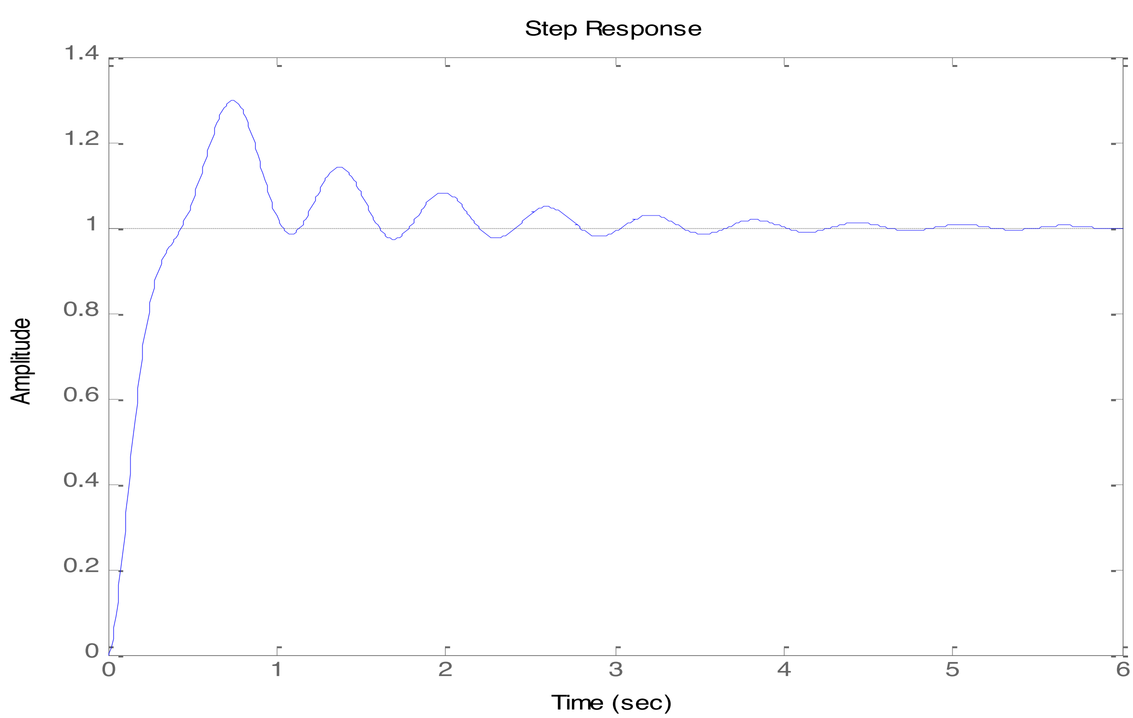
Part c)

K < 88.3 will resulted in a damping ratio of 0.707 or more. This was also found using $\phi = \sin^{-1}(\zeta)$. Can also see from the following plot:



Part d)

The step response of the system with a K = 88.3 is



Matlab Code:

```
clc; clear; format compact;
K = 88.3
Control = K*tf([1 1],[1 13])
Plant = tf([1 0 81], [1 0 100 0 0])
H = feedback(Control*Plant,1);
figure(1)
P = pzoptions;
P.Grid = 'on';
rlocusplot(Control*Plant,P)
figure(2)
step(H)
```

Problem 5.14

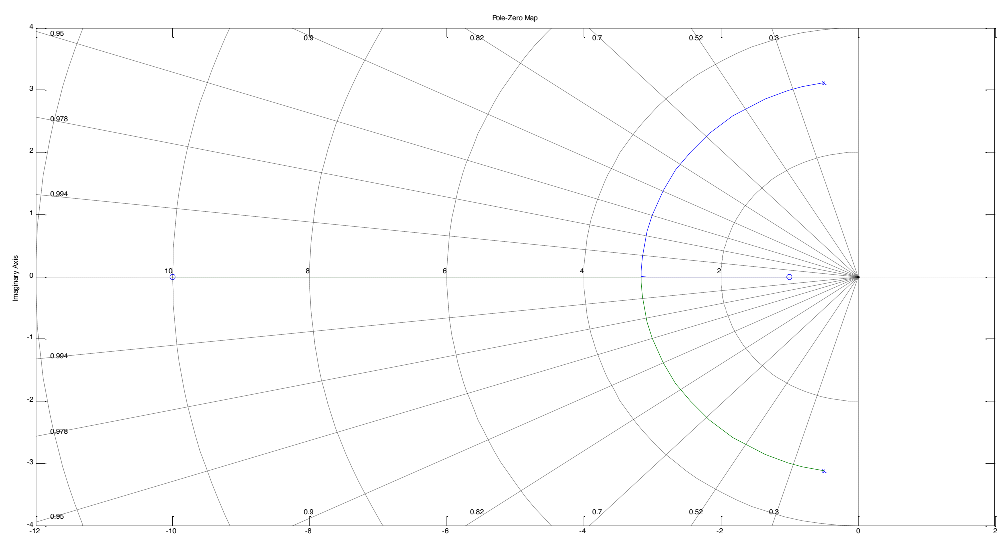
First find the closed loop transfer function:

$$\frac{10}{(s+1)s+10(ks+1)}$$

Now take the characteristic polynomial and put it in the form of 1+KL(s)=0 where L(s)=b(s)/a(s)

So we get that the characteristic equations is: $1+K\frac{10s}{s^2+s+10}=0$

Now we can get the root locus which is seen below:



Finally the gain K =0.27 gives a damping ratio of 0.5

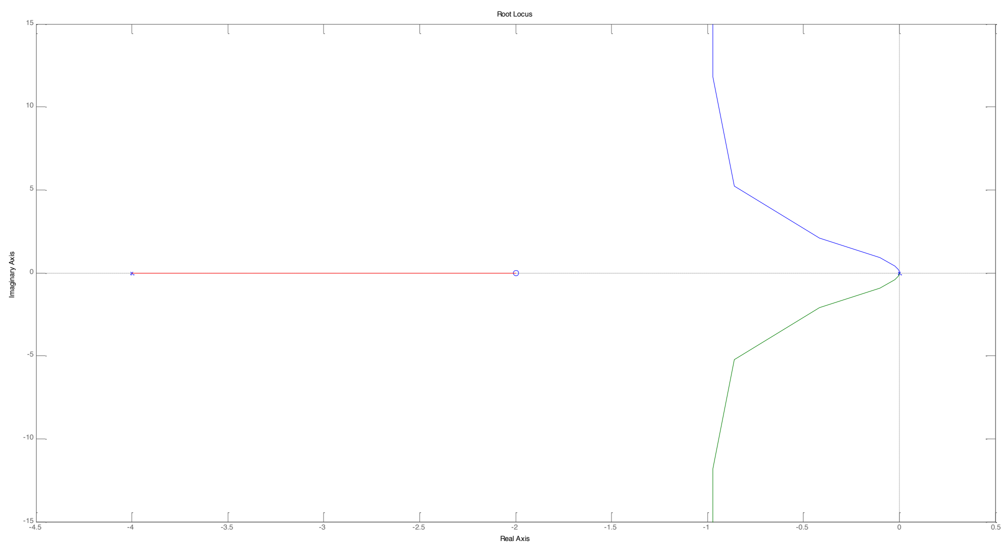
Matlab Code:

```
clc; clear; format compact;
```

```
K = 1
G = K*tf([10 0],[1 1 10])
P = pzoptions;
P.Grid = 'on';
rlocusplot(1+G,P)
```

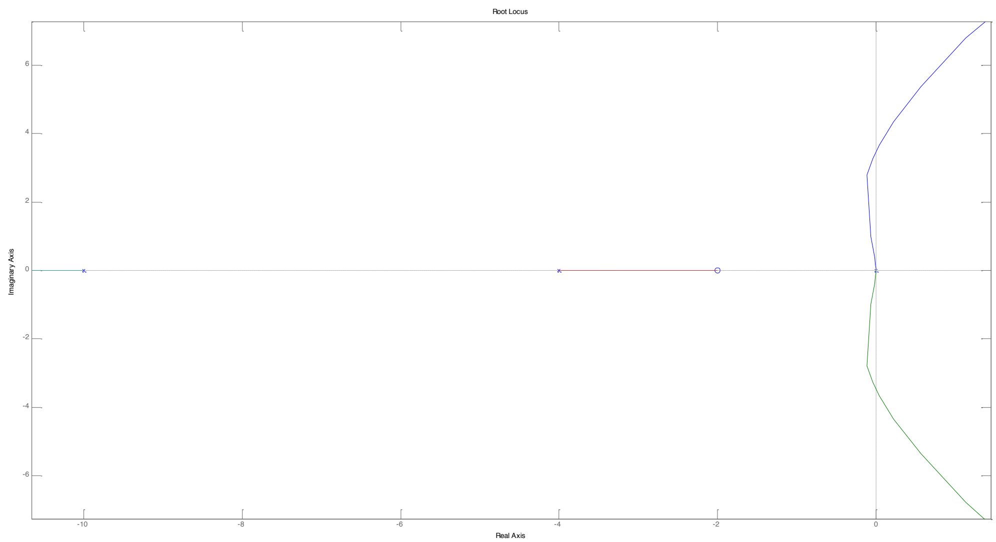
Problem 5.31:

Part a) From the plot below it can be seen that the system is stable for all K>0



Part b) Max dampening is 0.0633 with a K = 18.2

Note: The horizontal location of a pole is the inverse of the time constant so sensor = 1/(s+1/0.1)



Matlab Code:

```
K=1
G = tf(1,[1 0 0])
Sensor = tf(1,[1 1/.1])
H = K*tf([1 2],[1 4])
P = pzoptions;
P.Grid = 'on';
rlocusplot(G*H*Sensor,P)
rlocus(G*H*Sensor)
```