ECEN 4138 HW 7 Problem 5.13

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Housekeeping

```
clc; clear; close all;

addpath('..\')
```

Define L(s)

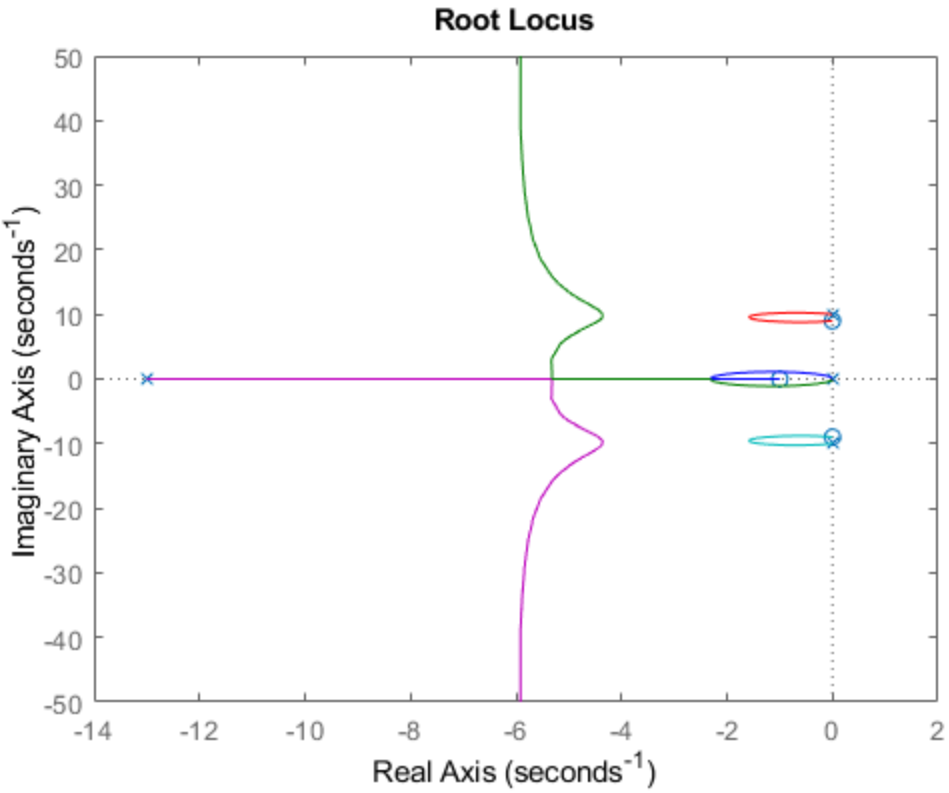
```
s = tf('s');

L1 = ((s+1)*(s^2+81))/(s^2*(s^2+100)*(s+13)); % L(s) for 5.13

L = L1; % Choose root locus
```

Plot root locus

```
figure
rlocus(L)
```



Find zeta = 0.707

```
% See math in homework, coefficients of characteristic equation such that s =
 sigma + sigma*j (zeta = sqrt(2)/2)
% Characteristic equation: s^5 + 13s^4 + (100+K)s^3 + (1300+K)s^2 + 81Ks + 81K
 = 0
polynom = [16 112 104 -912 32400 226800 210600];

sigRaw = roots(polynom);
sigmas = sigRaw(imag(sigRaw) == 0) % Only interested in real sigmas

K = sigmas.^3.*(4*sigmas.^2+52*sigmas+200)./(-2*sigmas.^3+81*sigmas+81)
```

```
sigmas =

   -5.1893
   -1.1101


K =

   88.4249
   32.5673
```

Simulate step response with these K's

```
for k = 1:length(K)
    T(k) = feedback(K(k).*L,1); % Unity feedback of K*L(s)

    figure
    step(T(k))
    titleText = sprintf("Step response for K = %.5f", K(k));
    title(titleText);
end
```

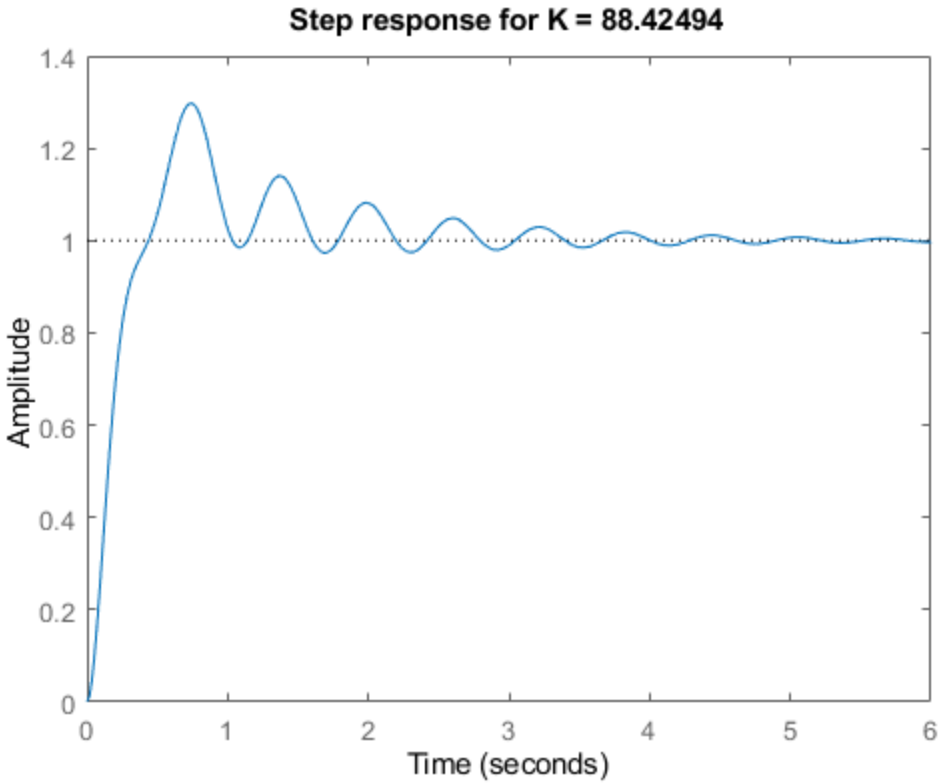
```
T
```

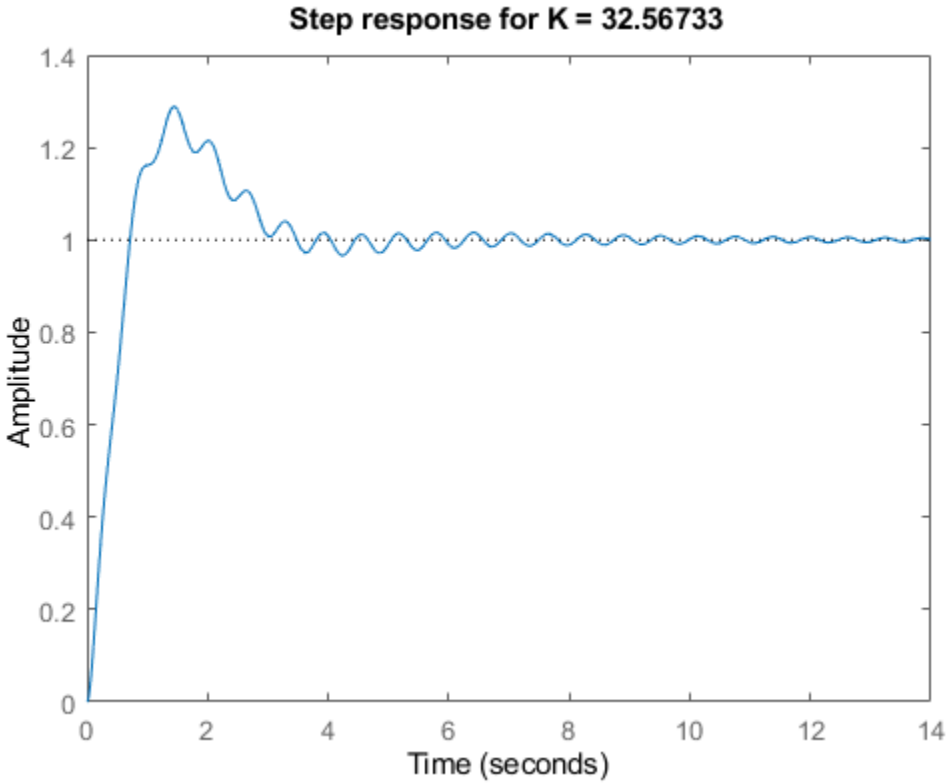
```
T =

  From input 1 to output:
         88.42 s^3 + 88.42 s^2 + 7162 s + 7162
  -----------------------------------------------------
  s^5 + 13 s^4 + 188.4 s^3 + 1388 s^2 + 7162 s + 7162

  From input 2 to output:
         32.57 s^3 + 32.57 s^2 + 2638 s + 2638
  -----------------------------------------------------
  s^5 + 13 s^4 + 132.6 s^3 + 1333 s^2 + 2638 s + 2638

Continuous-time transfer function.
```


Step response for K = 88.42494
Amplitude
Time (seconds)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
1
2
3
4
5
6


Step response for K = 32.56733
Amplitude
Time (seconds)
0
0.2
0.4
0.6
0.8
1
1.2
1.4
0
2
4
6
8
10
12
14

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