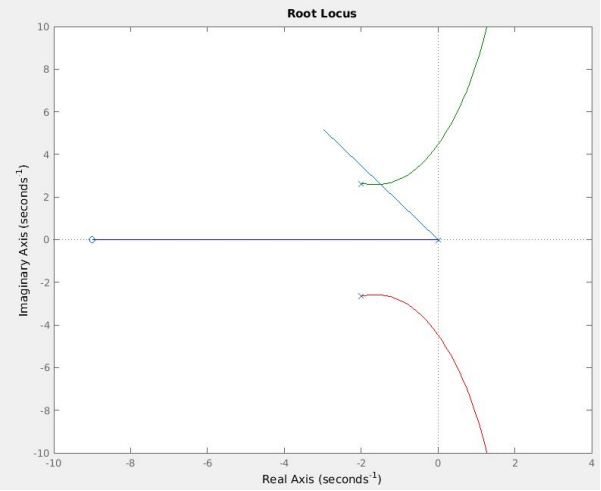
Assignment 4 - ELEC360 - Jakob Roberts - V00484900

B-6-6

$$G(s) = \frac{K(s+9)}{s(s^2+4s+11)}, \qquad H(s) = 1$$

- poles @ $s = 0$ and $s = -2 \pm \sqrt{7}$
- zeros @ $s = -9$
- asymptotes at +/- 90deg
- σ = 2.5
- angle off origin line from having damping ratio at 0.5 is +/- 60deg
- 60 converted to polar gives: -1.5 +/- j2.59
- extending this angle to intersect a branch, gives a **K =1**

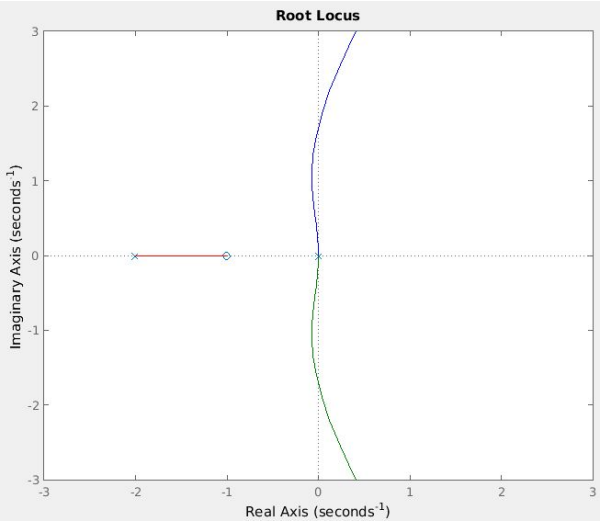


code:

```
numerator = [0 0 1 9];
denominator = [1 4 11 0];
rlocus(numerator,denominator);
hold
x = [0,-3];
y = [0,5.19];
line(x,y);
v = [-10 4 -10 10]; axis(v);
```

B-6-7

```
num = [0 0 0 2 2];
den = [1 7 10 0 0];
rlocus(num,den);
v = [-3 3 -3 3]; axis(v);
```



Use Routh stability analysis!

$$\frac{C(s)}{R(s)} = \frac{2k(s+1)}{s^4 + 7s^3 + 10s^2 + 2ks + 2k}$$

$$0 = s^4 + 7s^3 + 10s^2 + 2ks + 2k$$

s^4	1	10	2k
s^3	7	2k	
s^2	$\frac{70-2k}{7}$	2k	
s^1	$\frac{\frac{(70-2k)2k}{7} - 14k}{\frac{70-2k}{7}}$	0	
s^0	2k		

Stability requires 70>2k, 42>4k, and 2k>0, thus the stability range is **10.5 > K > 0**

B-6-11

With cancellations, the function becomes:

$$0 = 1 + \frac{K}{s^3 + 2s^2 + 6s}$$

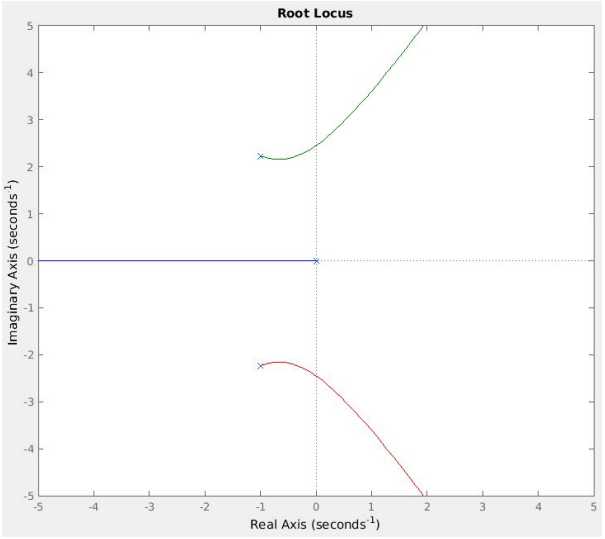
poles @ s=0, s = -1 +/- j root(5)

```
num = [0 0 0 1];
den = [1 2 6 0];
rlocus(num,den);
v = [-5 5 -5 5]; axis(v);

p = [1 2 6 2];
roots(p);
```

ans =

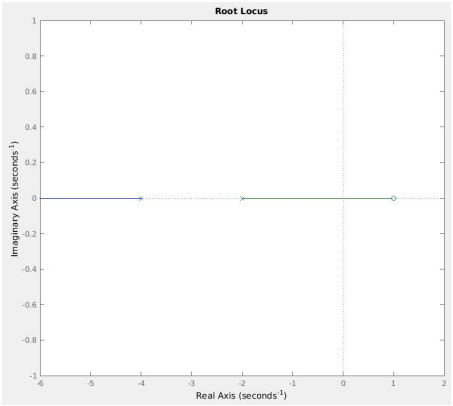
-0.8147 + 2.1754i
-0.8147 - 2.1754i
-0.3706 + 0.0000i



B-6-12

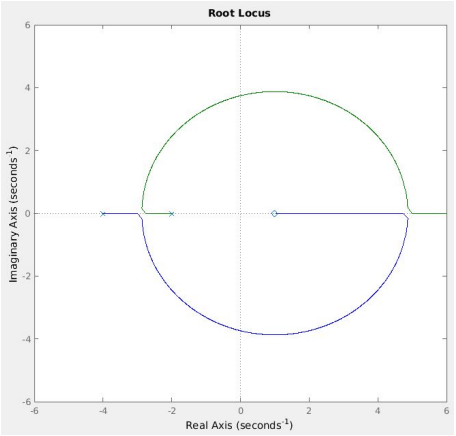
```
num = [0 1 -1];
den = [1 6 8];
k1 = 0:0.01:50;
k2 = 50:0.5:1000;
K = [k1 k2];

rlocus(num,den,K);
v = [-6 2 -1 1]; axis(v);
xlabel('Real Axis');
ylabel('Imaginary Axis');
```




```
num = [0 -1 1];
den = [1 6 8];
k1 = 0:0.01:50;
k2 = 50:0.5:1000;
K = [k1 k2];

rlocus(den,num,K);
v = [-6 6 -6 6]; axis(v);
xlabel('Real Axis');
ylabel('Imaginary Axis');
```



B-6-14

poles @ $s = 0$ and $s = -2 \pm \sqrt{7}$

- asymptotes at +/- 60deg
- σ = 4/3

- angle off origin line from having damping ratio at 0.5 is +/- 60deg
- 60 converted to polar gives: -2 +/- j3.48

```
num = [0 0 0 1];
den = [1 4 5 0];
rlocus(num,den);
v = [-6 2 -1 1]; axis(v);
hold
x = [0,-2];
y = [0,3.48];
line(x,y);
v = [-4 4 -4 4]; axis(v);
```