

ECE 141 Homework 4

Lawrence Liu

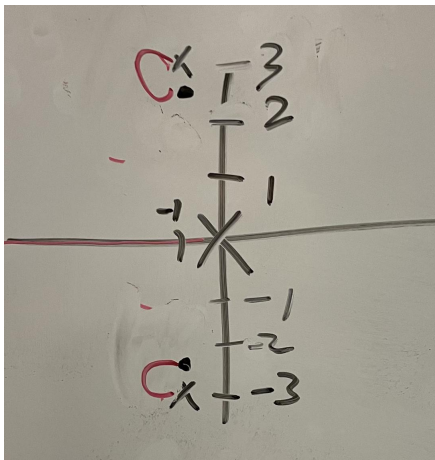
May 17, 2022

Problem 5.5

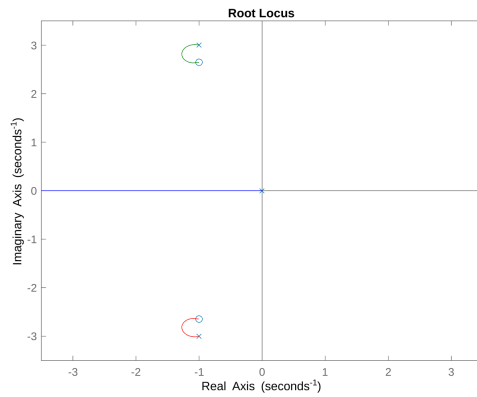
(c)

$L(s)$ has zeros at $\frac{-2 \pm j2\sqrt{7}}{2}$, and poles at 0 and $\frac{-2 \pm j6}{2}$, therefore we have $\alpha = 0$
 $\phi_1 = 180^\circ$, And the departure angle for poles $-1 \pm 3j$ is $\pm 161.565^\circ$, And the arrival angle for the zeros $-1 \pm \sqrt{7}j$ is $\pm 200^\circ$

Therefore the sketch for the root locus looks like the following



This corresponds well with the matlab root locus plot:



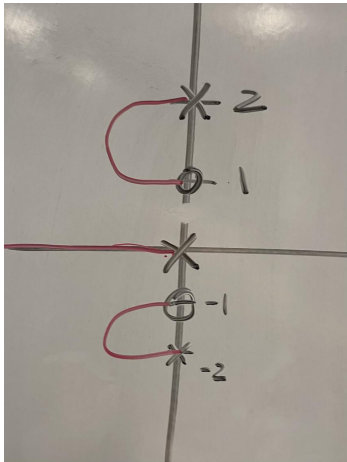
That was produced with this code

```
sys = tf([1 2 8],[1 2 10 0]);
rlocus(sys)
ylim([-3.5 3.5])
xlim([-3.5 3.5])
```

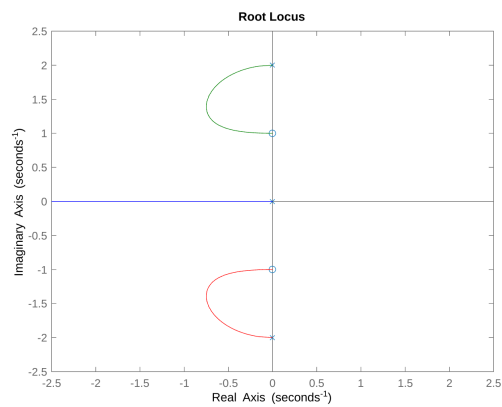
(e)

$L(s)$ has zeros at $\pm j$, and poles at 0 and $\pm 2j$, therefore we have $\alpha = 0$
 $\phi_1 = 180^\circ$, And the departure angle for poles $\pm 2j$ is 180° , And the arrival angle for the zeros $\pm 1j$ is 180°

Therefore the sketch for the root locus looks like the following



This corresponds well with the matlab root locus plot:



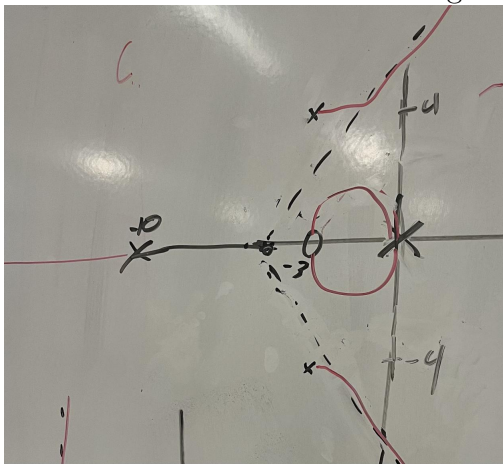
That was produced with this code

```
sys = tf([1 0 1],[1 0 4 0]);
rlocus(sys)
ylim([-2.5 2.5])
xlim([-2.5 2.5])
```

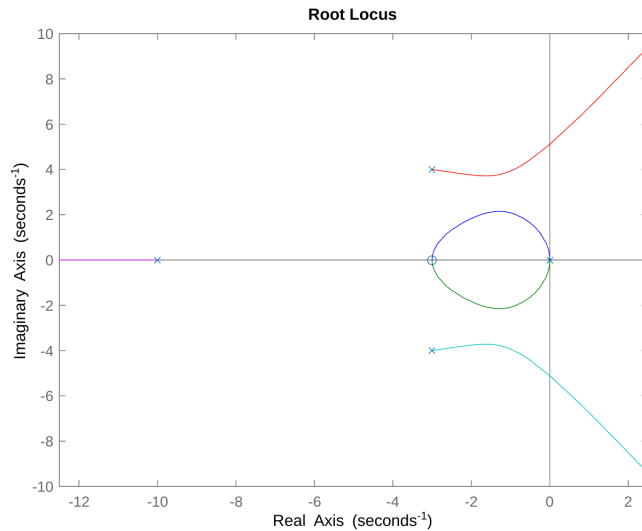
Problem 5.7

(c)

This function has 2 zeros at -3 and 5 poles: 2 at 0 , 1 at -10 , and 2 at $-3 \pm 4j$. Therefore $\alpha = -3.333$ and that the three branches intersecting the real axis, intersect at degrees of 60° , 180° , and 300° , therefore we have for pole $-10 + 0j$, departure angle 1: 180°
for poles $-3 \pm 4j$ the departure angles are $\pm 13.484^\circ$
for the dual poles at the 0 the departure angles are $\pm 90^\circ$
for the dual zeros at 0 the arrival angles are $\pm 90^\circ$. Therefore the sketch for the root locus looks like the following



This corresponds well with the matlab root locus plot:



That was produced with this code

```
sys = tf([1 6 9],[1 16 85 250 0 0]);
rlocus(sys)
ylim([-10 10])
xlim([-12.5 2.5])
```

(e)

$L(s)$ had zeros at $-1 \pm 1j$ and 4 poles, 2 at 0, 1 at -2 and -3 . Therefore we have

$$\alpha = -1.5$$

And there are two lines asymptomatic to this at angles of $\pm 90^\circ$

We have

for pole -3 , departure angle 1: 0.0°

for pole -2 , departure angle 1: 180°

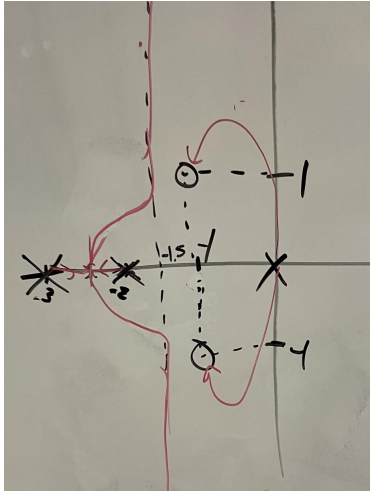
for pole 0 , departure angle 1: 270°

for pole 0 , departure angle 2: 90°

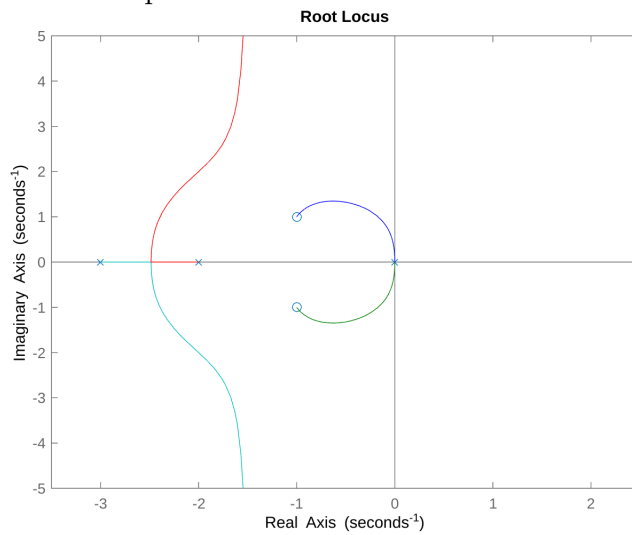
for zero $-1 \pm 1j$, arrival angle: $\pm 71.565^\circ$

Furthermore from Rule 6 we have that there are multiple roots where $s =$

-2.485 , therefore the sketch of the root locus looks like



This corresponds well with the matlab root locus plot:



That was produced with this code

```
sys = tf([1 2 2],[1 5 6 0 0]);
rlocus(sys)
ylim([-5 5])
xlim([-3.5 2.5])
```

Problem 5.8

(e)

$L(s)$ has a zero at -2 and 4 poles, 2 at -6 , one at 0 , and one at 1 . Therefore,

$$\alpha = -3$$

and three lines are asymptomatic to it at angles of 180° , 60° , and 180° . For the poles we have that:

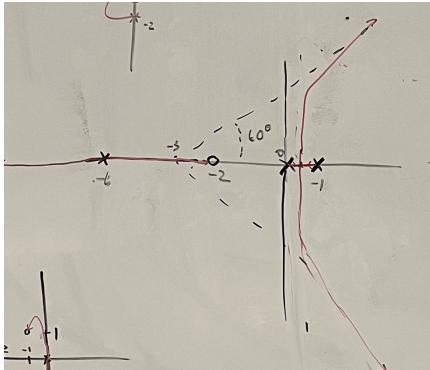
for pole -6 , departure angle 1: 180°

for pole -6 , departure angle 2: 0°

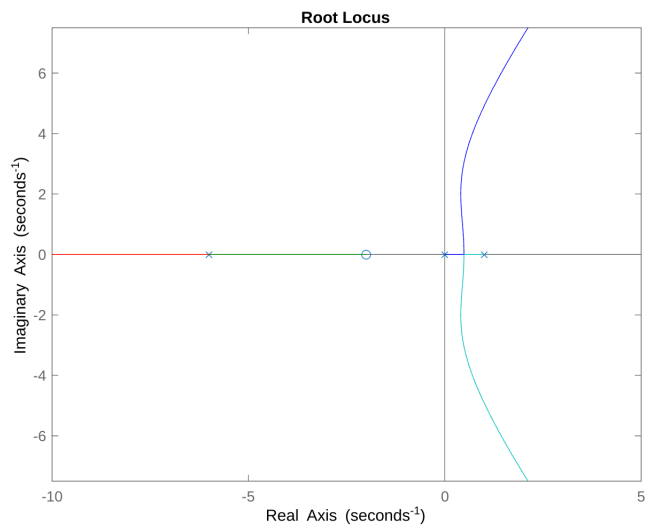
for pole 0 , departure angle 1: 0°

for pole 1 , departure angle 1: 180°

and for the zero we have that the angle of arrival is 180° . Furthermore from Rule 6 we have that there are multiple roots where $s = -6, 0.488$, therefore the sketch of the root locus looks something like



This corresponds well with the matlab root locus plot:



That was produced with this code

```
sys = tf([1 2],[1 11 24 -36 0]);  
rlocus(sys)  
ylim([-7.5 7.5])  
xlim([-10 5])
```