Tecnológico de Monterrey

Control engineering

PhD. Enrique Aguayo

Third
Simulation Project

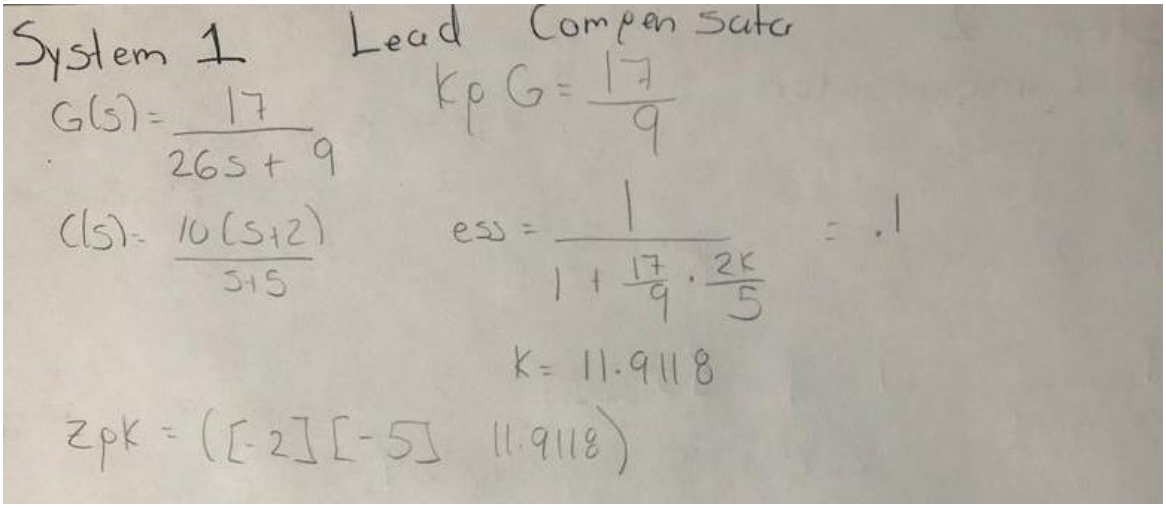
José Abraham Pérez Martínez
A01633926

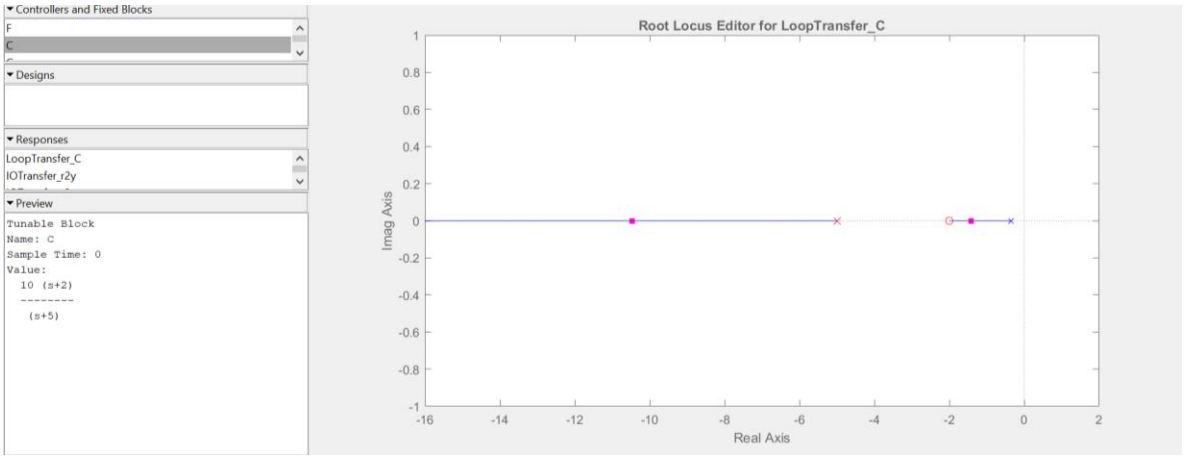
System1

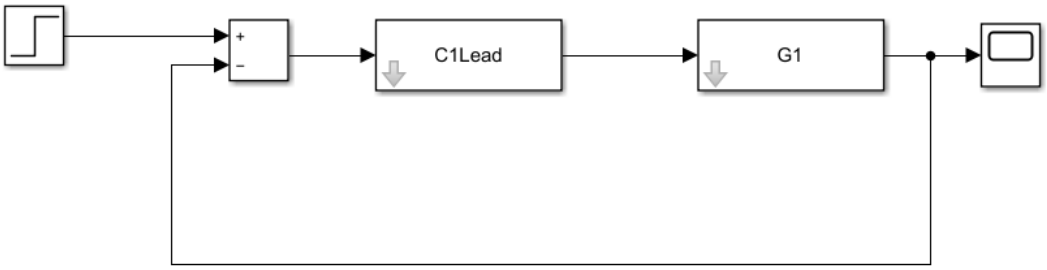
Lead Compensator

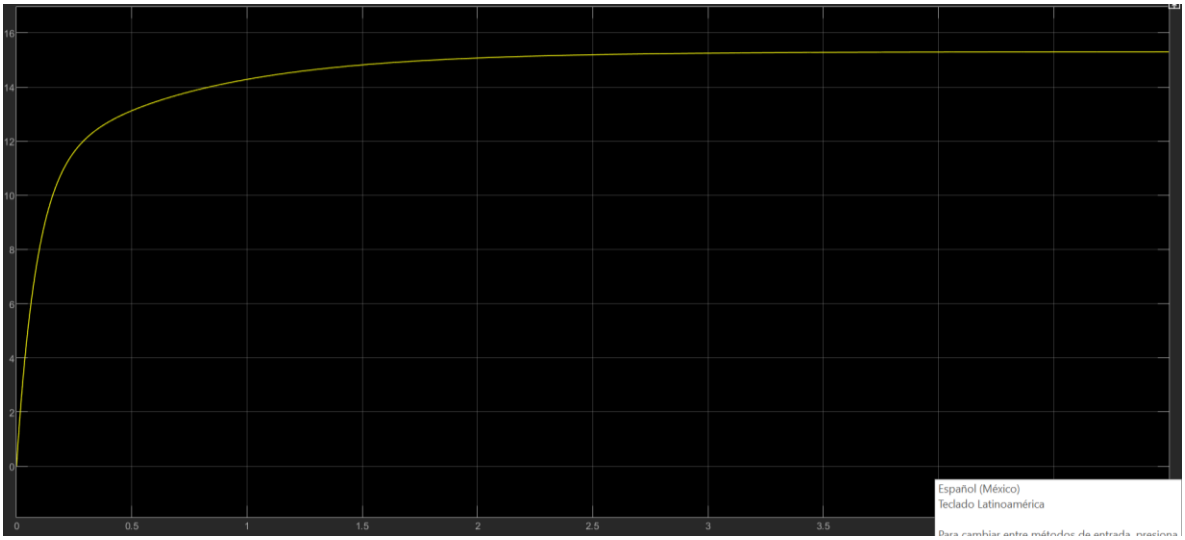
```
G1 =

     17
  --------
  26 s + 9

Continuous-time transfer function.
```

```
C1Lead =

  11.912 (s+2)
  ------------
     (s+5)

Continuous-time zero/pole/gain model.
```



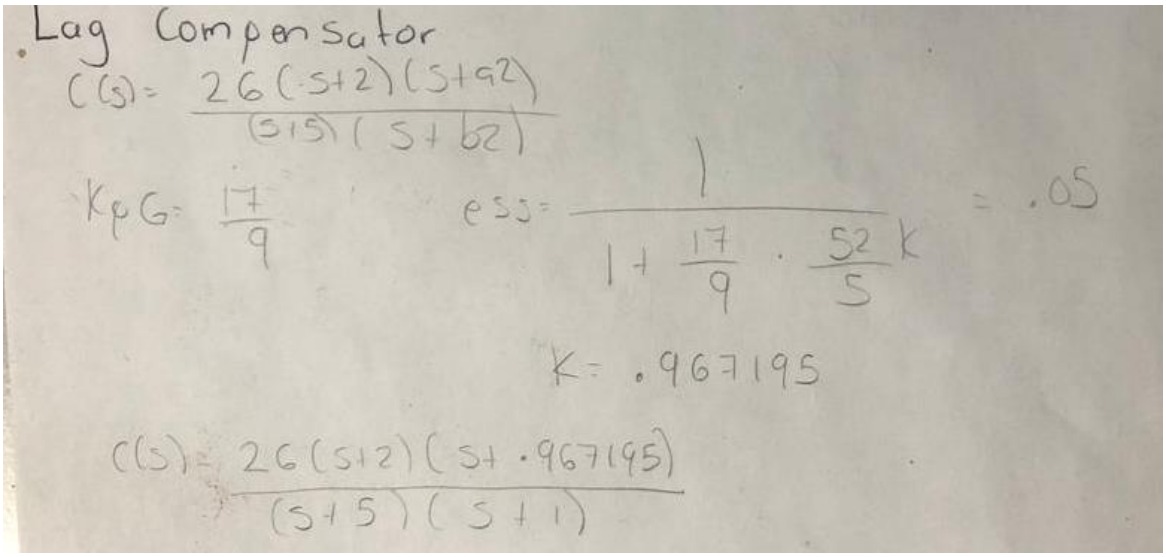




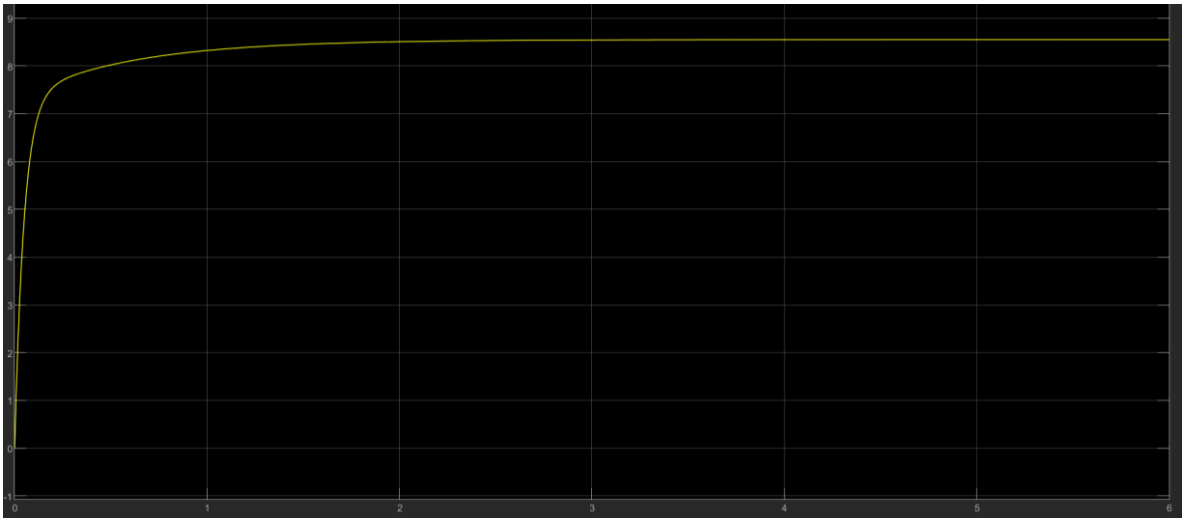


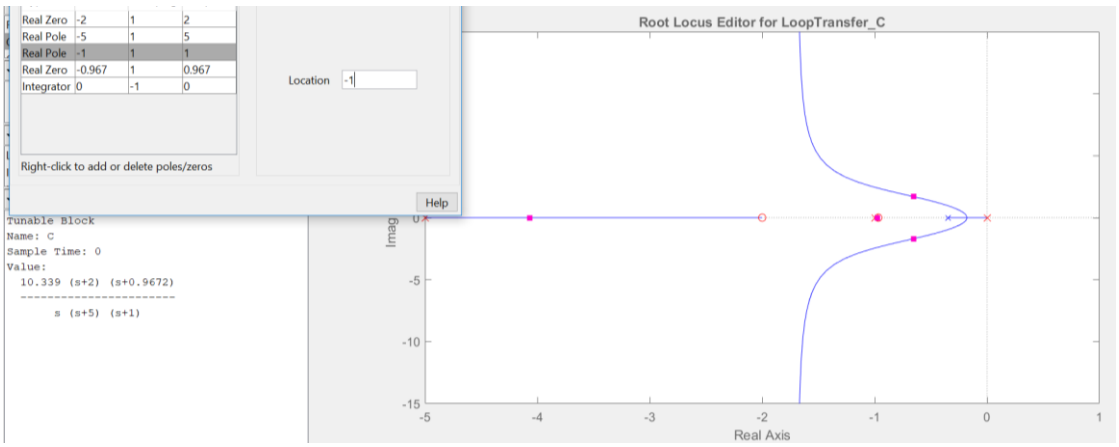
Lag Compensator

```
C1Lag =

  26 (s+2) (s+0.9672)
  -------------------
      (s+5) (s+1)

Continuous-time zero/pole/gain model.
```




+
−
C1Lag
G1


9
8
7
6
5
4
3
2
1
0
-1
0
1
2
3
4
5
6

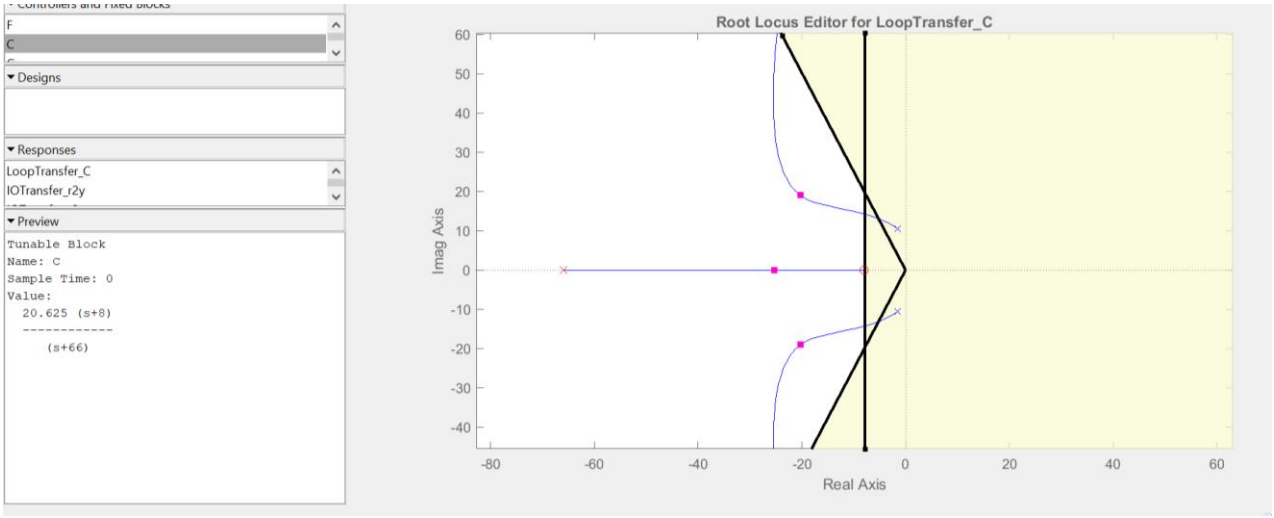

Real Zero -2 1 2
Real Pole -5 1 5
Real Pole -1 1 1
Real Zero -0.967 1 0.967
Integrator 0 -1 0
Right-click to add or delete poles/zeros
Location -1
Help
Tunable Block
Name: C
Sample Time: 0
Value:
10.339 (s+2) (s+0.9672)
s (s+5) (s+1)
Root Locus Editor for LoopTransfer_C
Imag
0
-5
-10
-15
-5
-4
-3
-2
-1
0
1
Real Axis

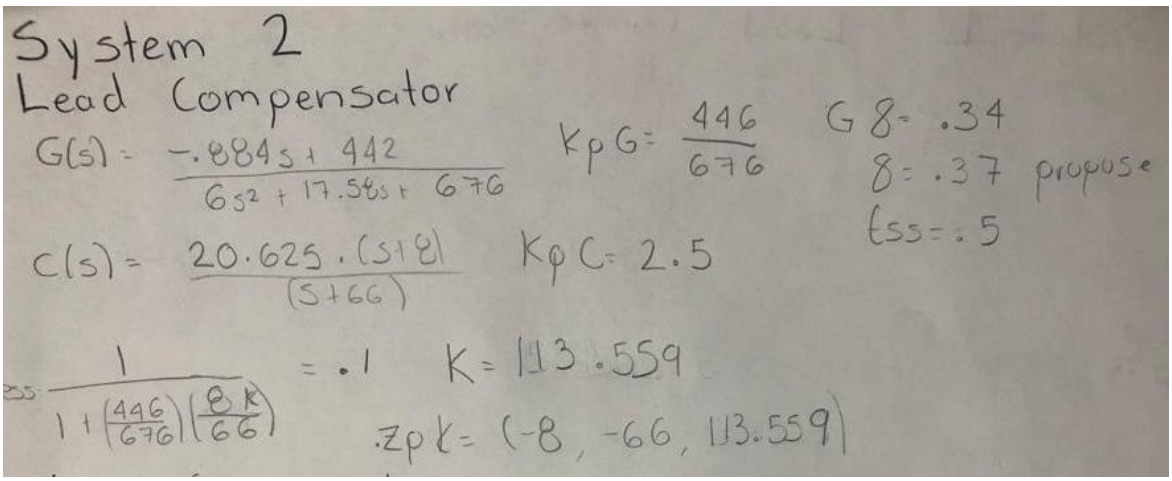
System 2

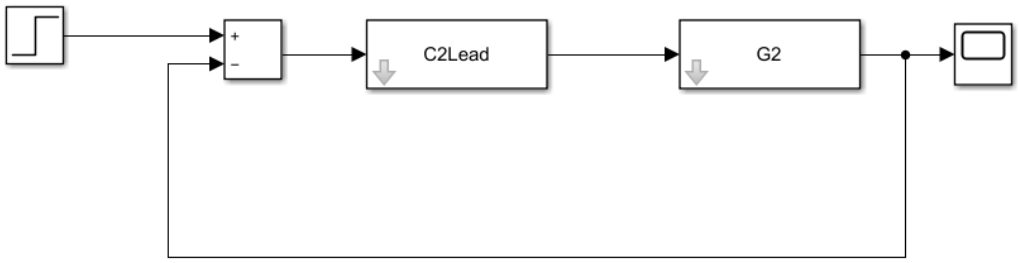
Lead Compensator

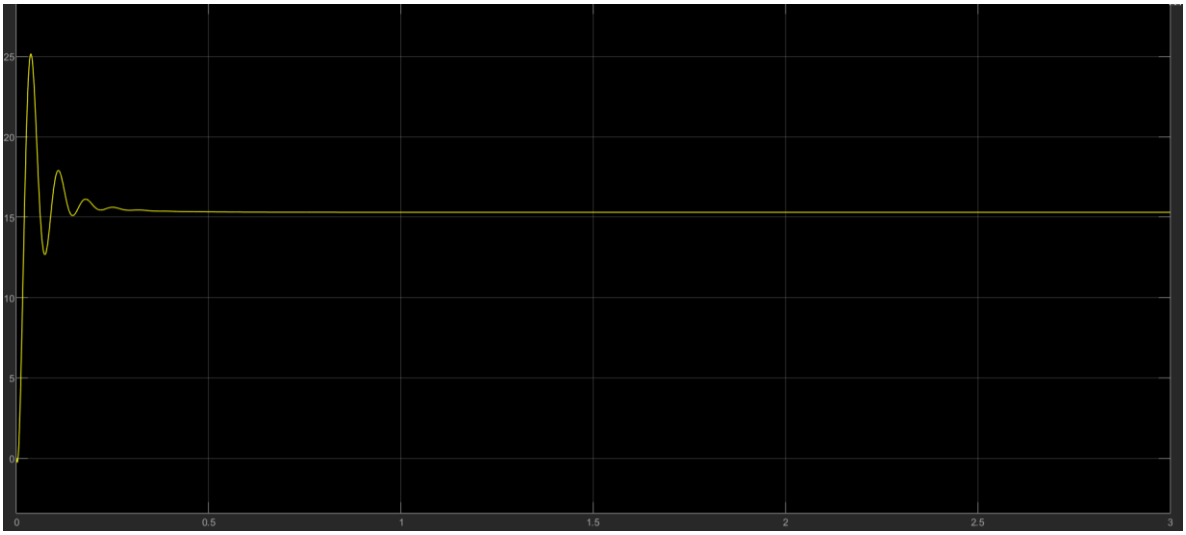
```
G2 =

      -0.884 s + 442
  ----------------------
  6 s^2 + 17.58 s + 676

Continuous-time transfer function.
```

```
C2Lead =

  113.56 (s+8)
  ------------
     (s+66)

Continuous-time zero/pole/gain model.
```









Lag Compensator

```
C2Lag =

  26 (s+8) (s+9.221)
  ------------------
     (s+66) (s+1)

Continuous-time zero/pole/gain model.
```

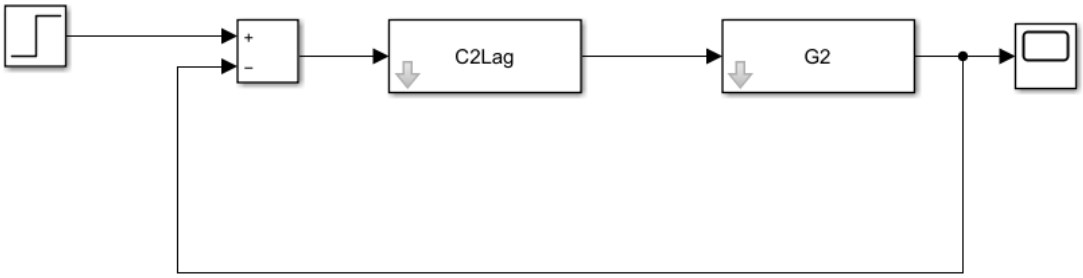
Lag Compensator

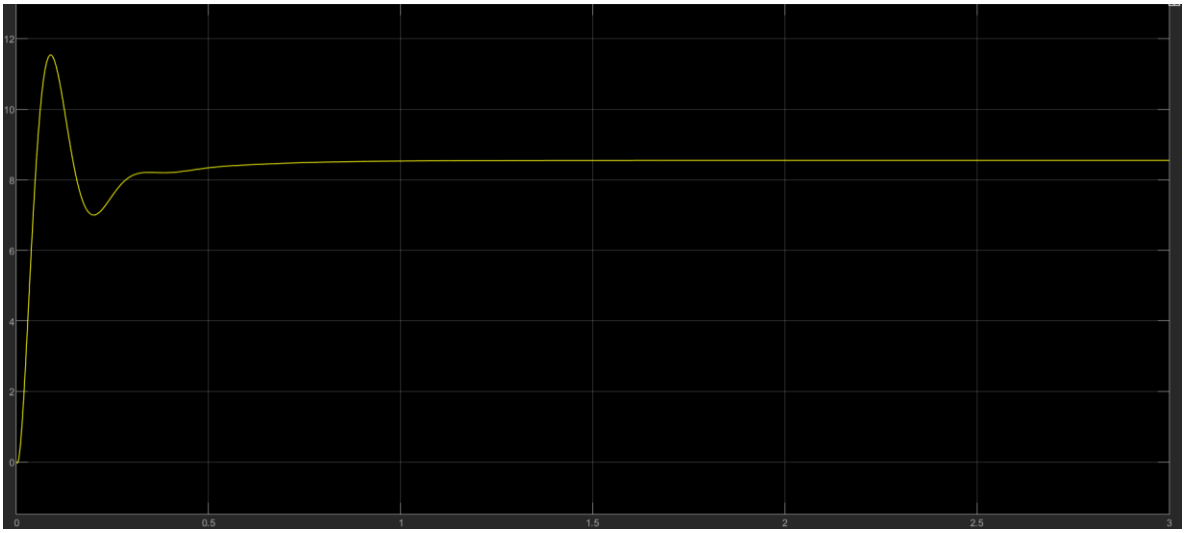
Maximum input = 26

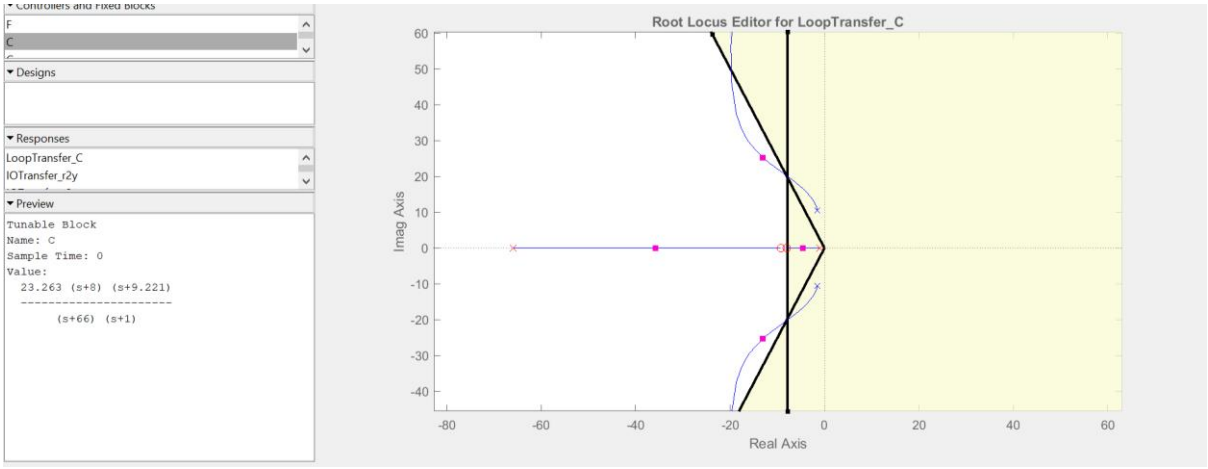
$K_pG = \frac{446}{676}$ $C(s) = \frac{26(s+8)(s+a2)}{(s+66)(s+b2)}$

$e_{ss} = \frac{1}{1+\frac{446}{676}\cdot\frac{208k}{66}} = .05$ $K = 9.22059$

$C(s) = \frac{26(s+8)(s+9.22059)}{(s+66)(s+1)}$





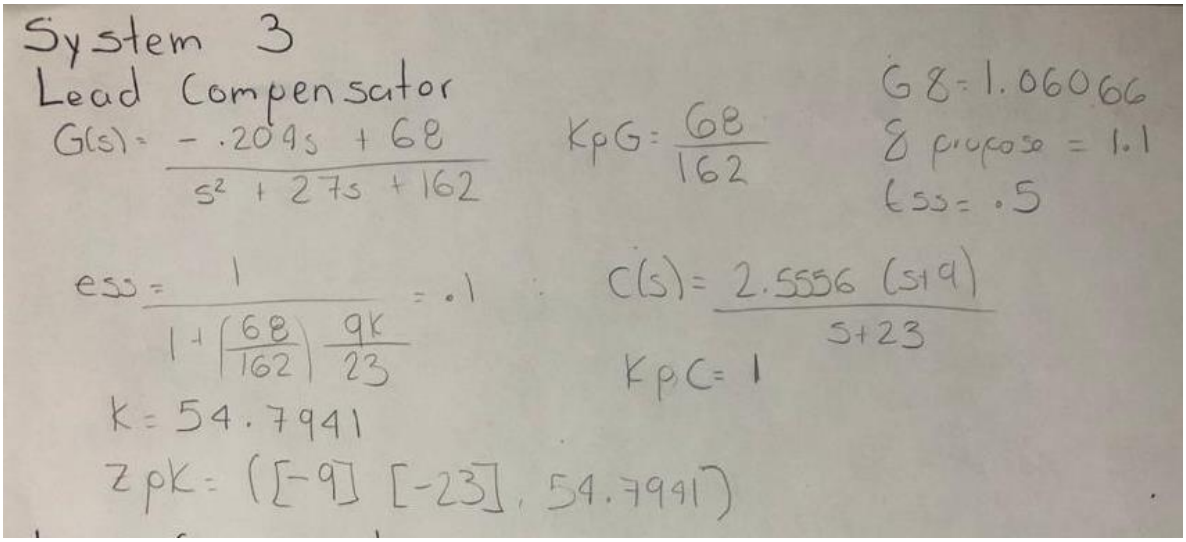


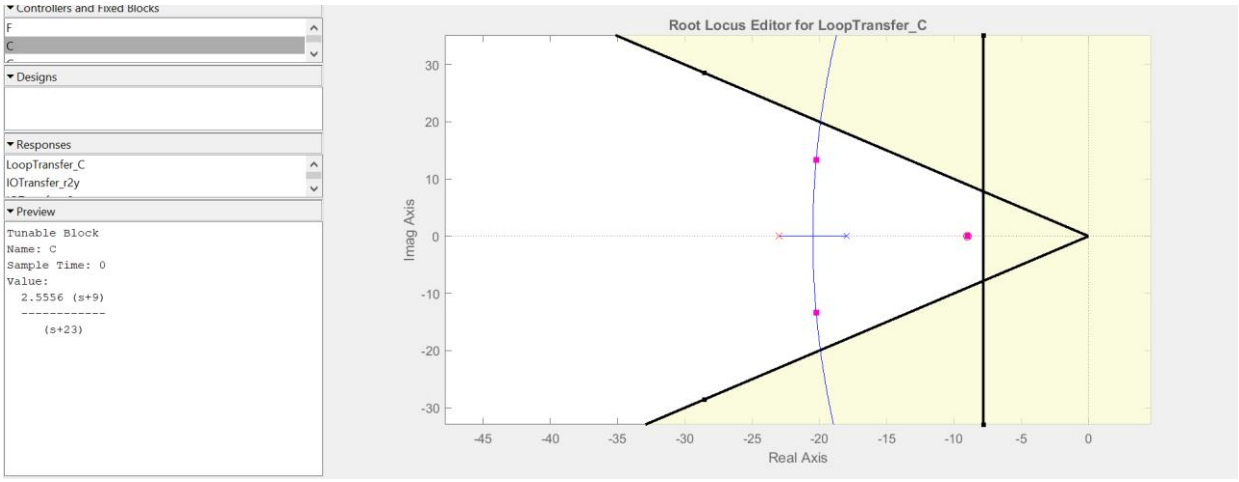
System3

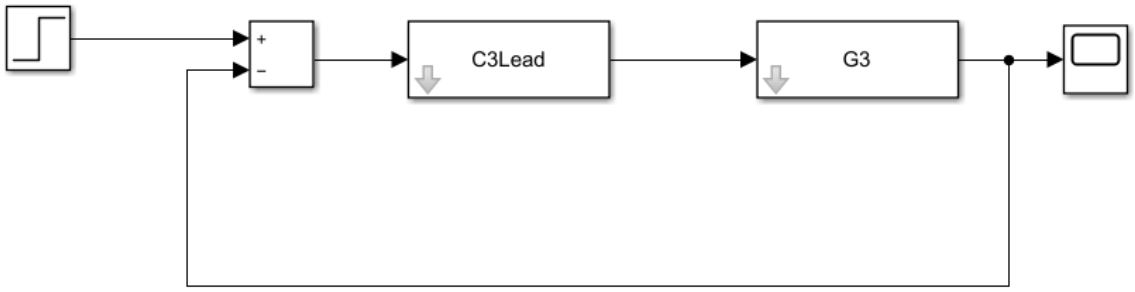
Lead Compensator

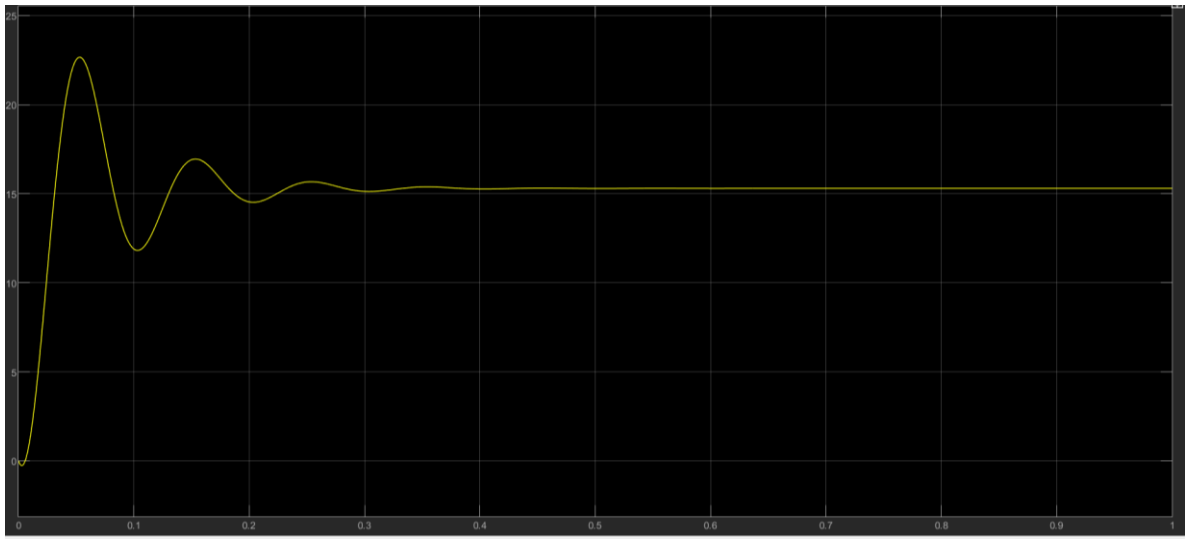
```
G3 =

   -0.204 s + 68
  ----------------
  s^2 + 27 s + 162

Continuous-time transfer function.
```

```
C3Lead =

  54.794 (s+9)
  ------------
     (s+23)

Continuous-time zero/pole/gain model.
```



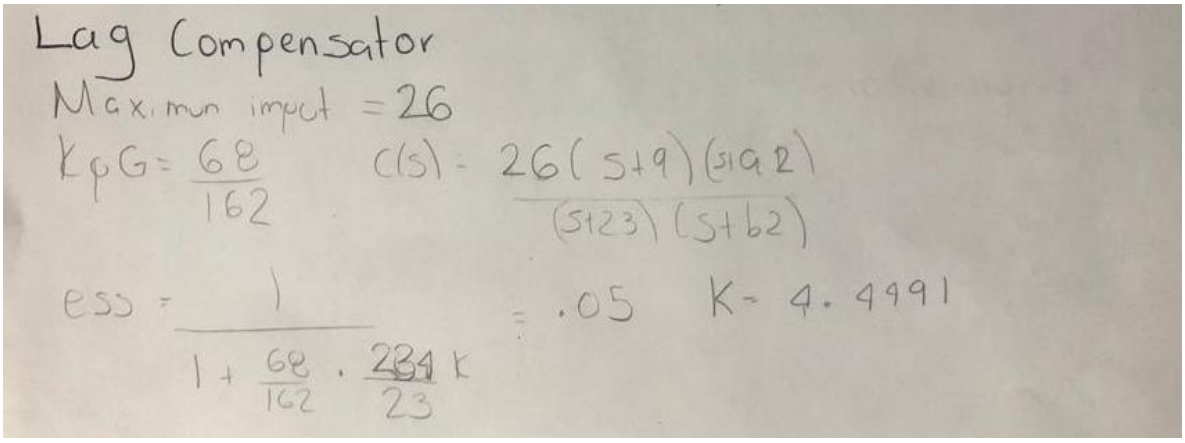

Controllers and Fixed Blocks
F
C
Designs
Responses
LoopTransfer_C
IOTransfer_r2y
Preview
Tunable Block
Name: C
Sample Time: 0
Value:
2.5556 (s+9)
(s+23)
Root Locus Editor for LoopTransfer_C
Imag Axis
Real Axis
30
20
10
0
-10
-20
-30
-45
-40
-35
-30
-25
-20
-15
-10
-5
0

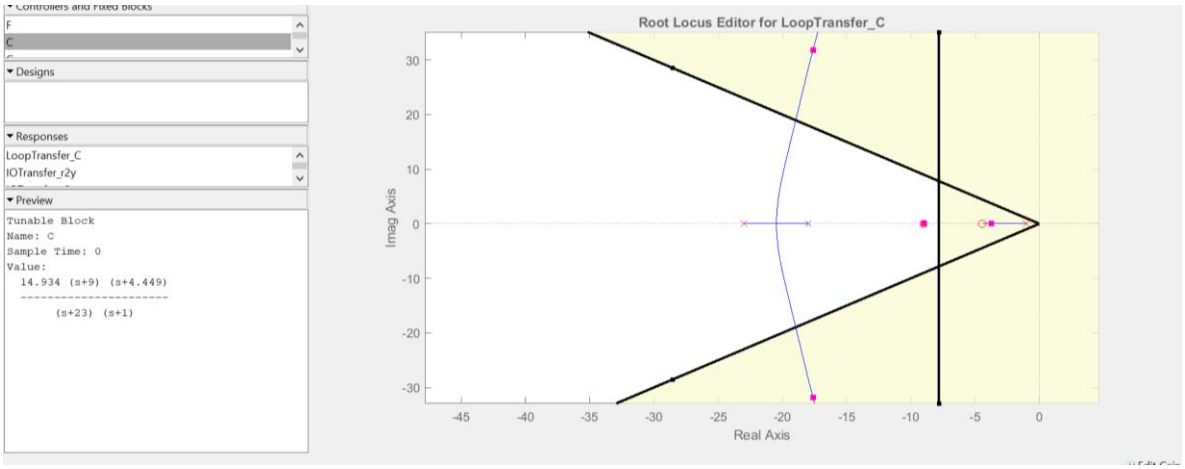

+
−
C3Lead
G3

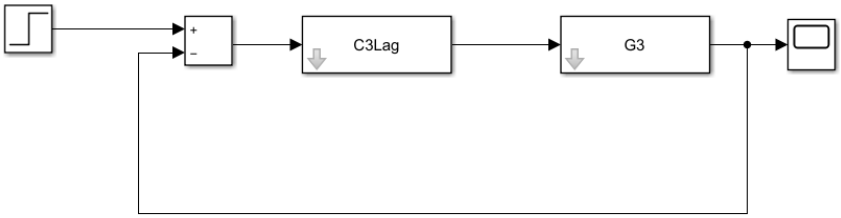

25
20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

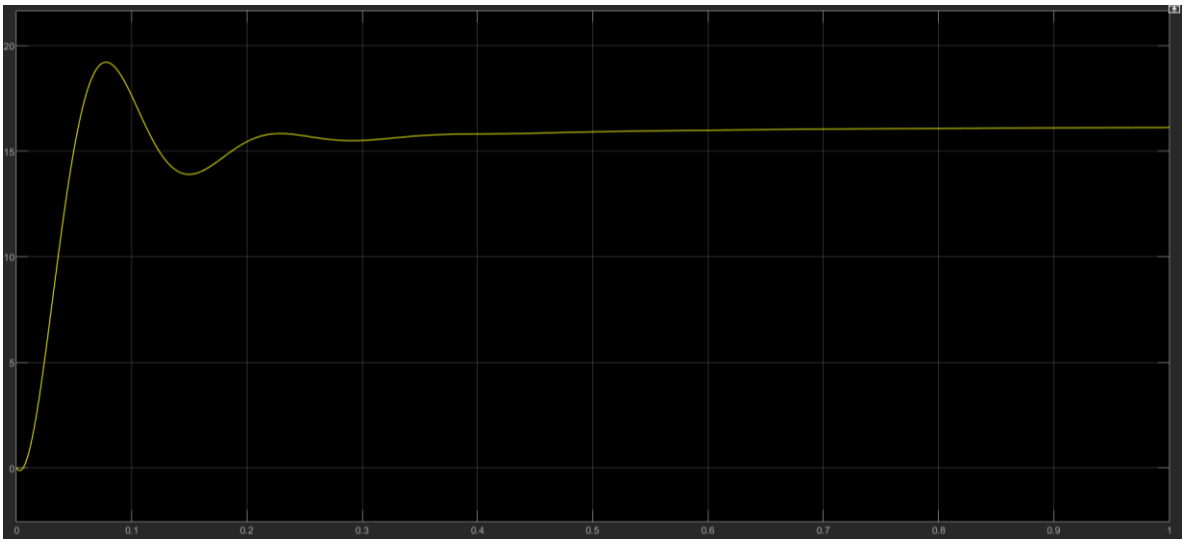
Lag Compensator

```
C3Lag =

  26 (s+9) (s+4.449)
  ------------------
     (s+23) (s+1)

Continuous-time zero/pole/gain model.
```






+
-
C3Lag
G3


20
15
10
5
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

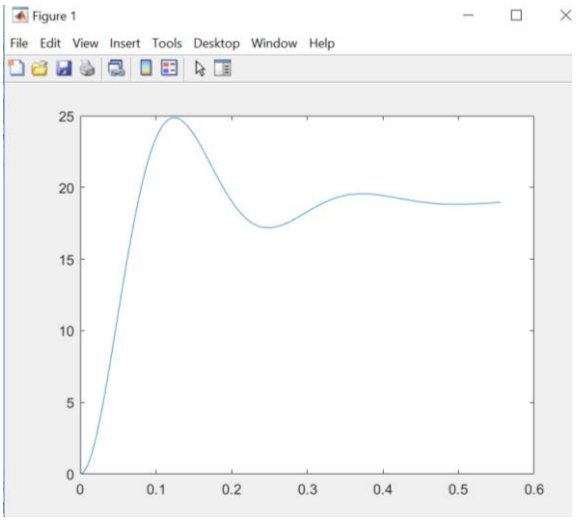
System 4

With the following script I obtain the transfer function

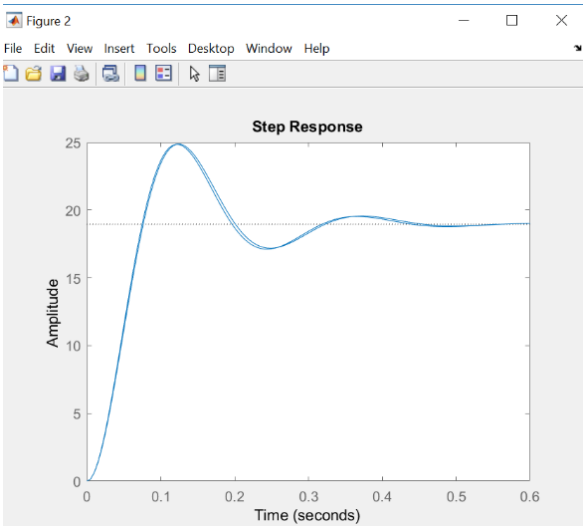
```
close all
t=zeros(); %arreglo de tiempo
k=zeros(); % arreglo de la ganancia
[fil,col]=size(Out); % declaro el arreglo para leer la posicion de los valores de la funcion
t=Out(:,1);%Datos del tiempo obtenidos de la tf G mediante simulink
k=Out(:,2);%Datos de la ganancia obtenidos de la tf G mediante simulik
figure;
plot(t,k); %grafica de la tf

%identificar el #orden del sistema
pico=max(k);
final=k(end);
if   pico == final
    z = 1;

else
    z = 2;

end
%implementacion una vez conocido el orden del sistema
if z==1
        Orden=1
        for y=1:fil
            if Out(y,2) > final*0.9933  %Encontrar el valor de 5Tao
                pos=y             %Posicion del arreglo donde esta 5tao
                break

            else
            end

        end
       Tss=Out(pos,1);
       Tao=Tss/5;
      ktf=final;
      G1=tf(ktf,[Tao 1])
      figure;
      plot(t,k);
      hold on
      step(G1)
else
   Orden=2
   for y=1:fil
            if Out(y,2) == pico
                tpa=y;
                break

            else
            end

        end
    tp=Out(tpa,1);
    wd=pi/tp;
    mp=((pico-final)/final);
    delta=-(log(mp))/(sqrt(log(mp)^2 + pi^2));
    wn=wd/sqrt(1-delta^2);
    ks2=final;
    G2=tf((ks2*wn^2),[1 (2*delta*wn) (wn^2)])
    figure;
    plot(t,k);
    hold on
    step(G2)
end
```

```
>> G4

G4 =

          14340
  ----------------------
  s^2 + 19.14 s + 756.5

Continuous-time transfer function.
```

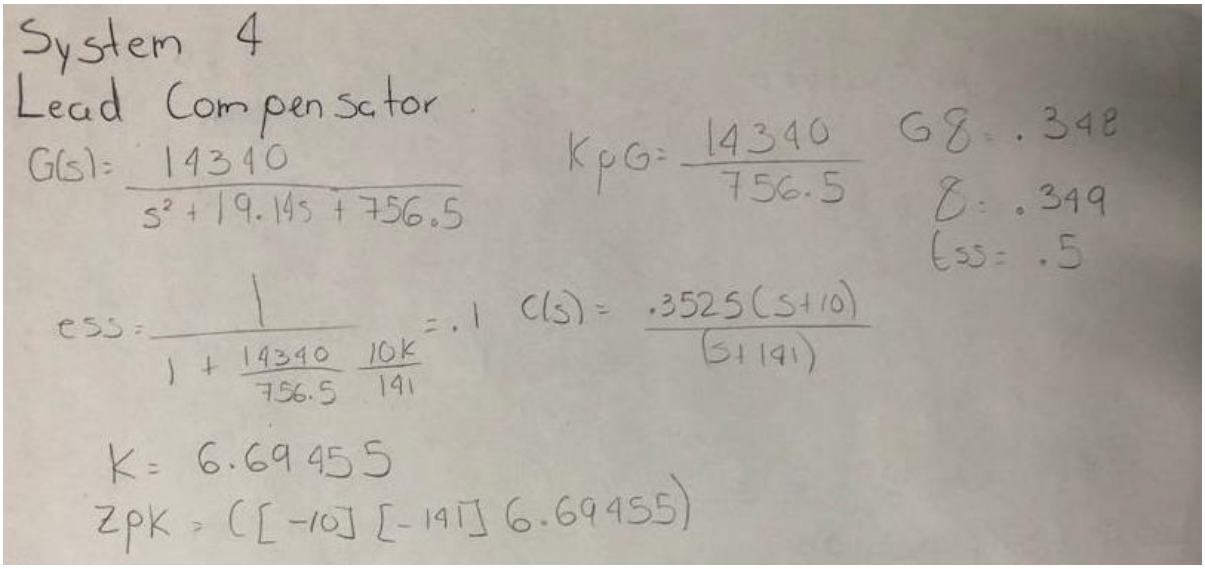
Original function



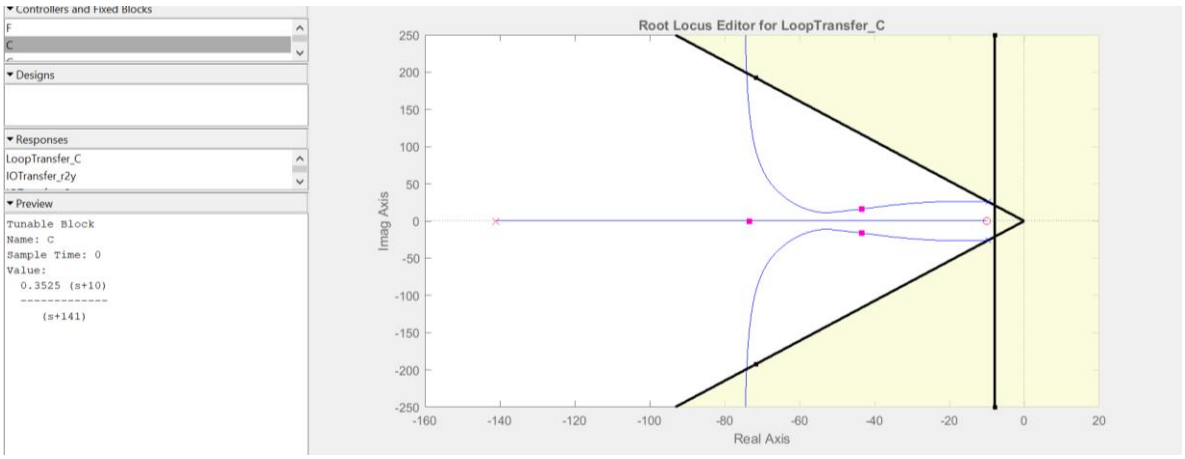
Approximate function

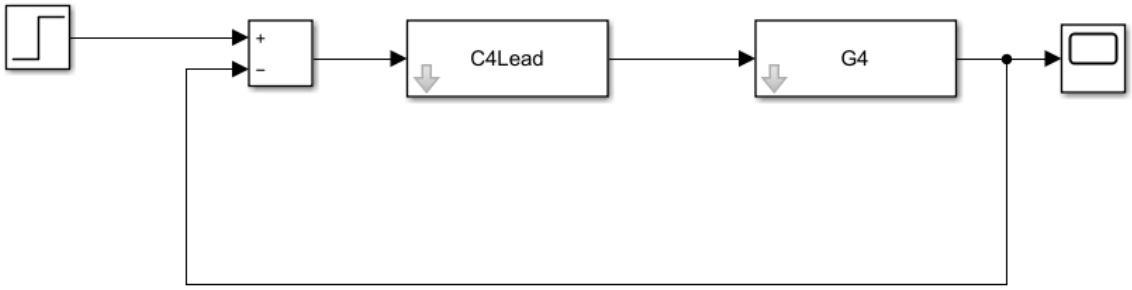


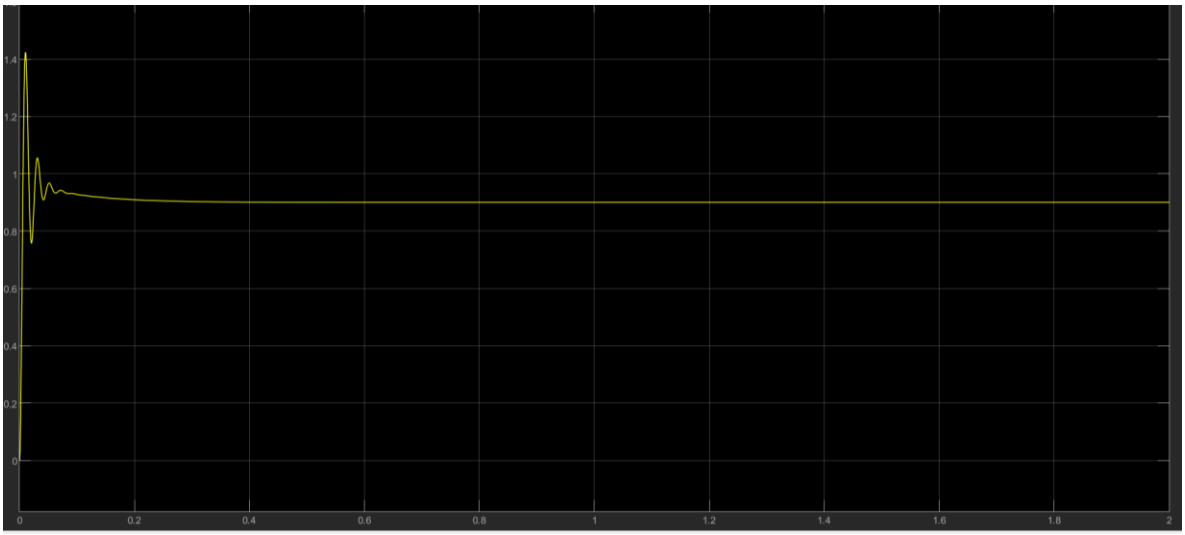
Lead Compensator



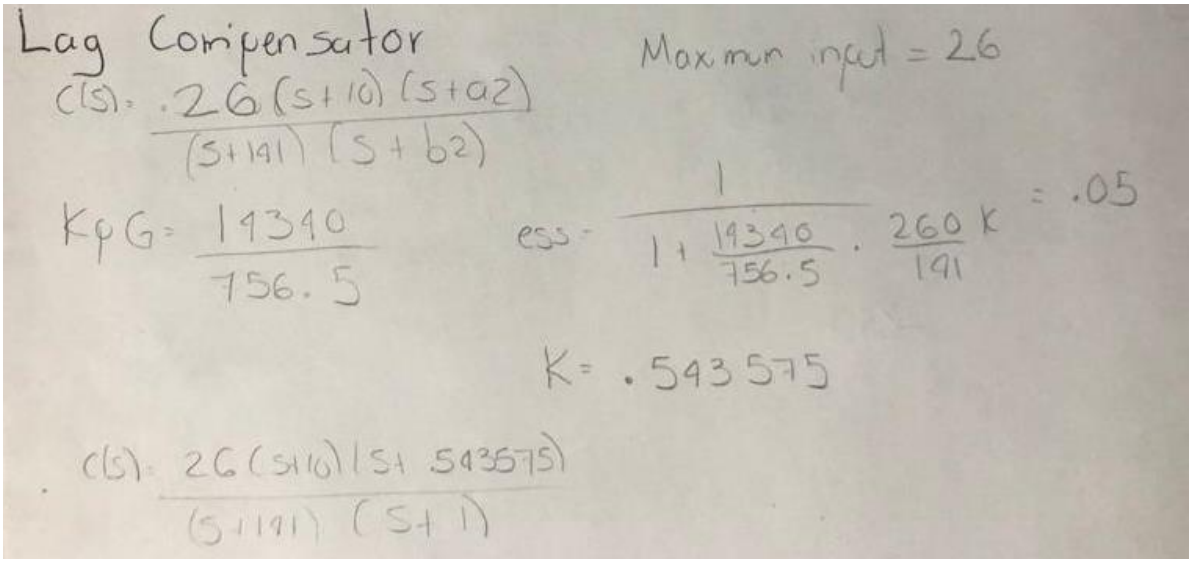
```
C4Lead =

  6.6945 (s+10)
  -------------
     (s+141)

Continuous-time zero/pole/gain model.
```



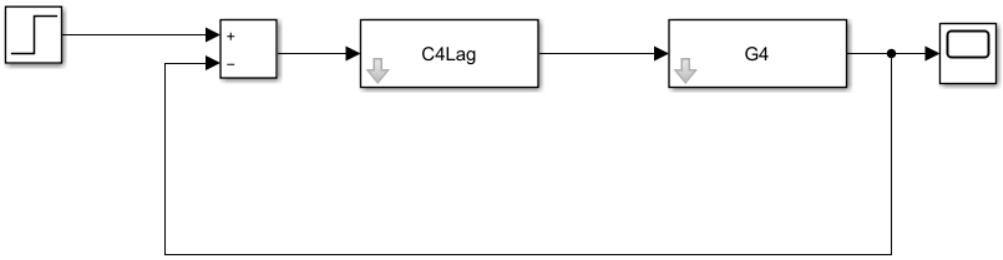


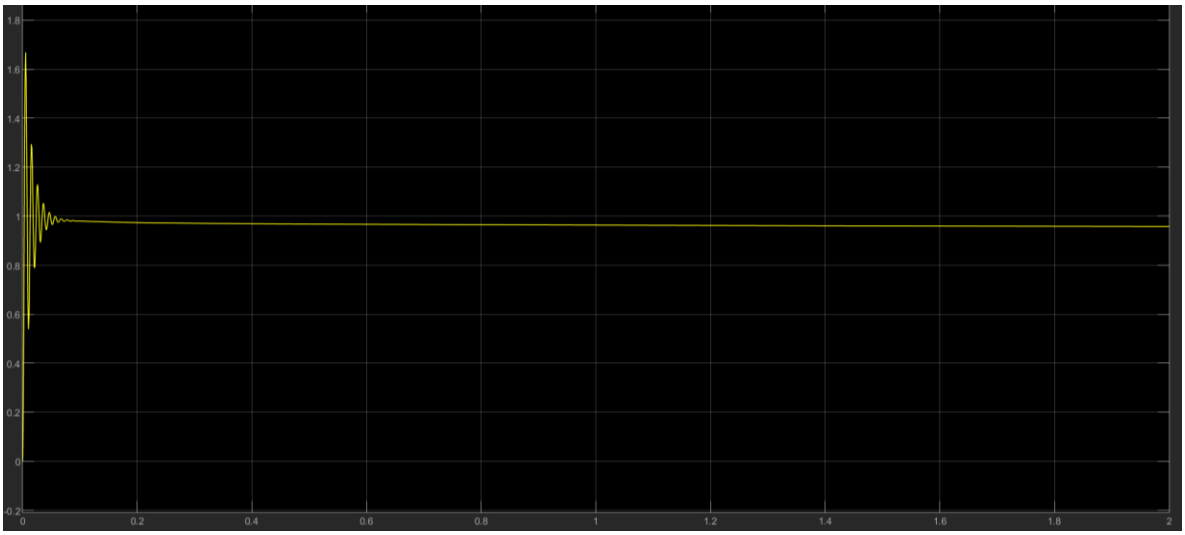


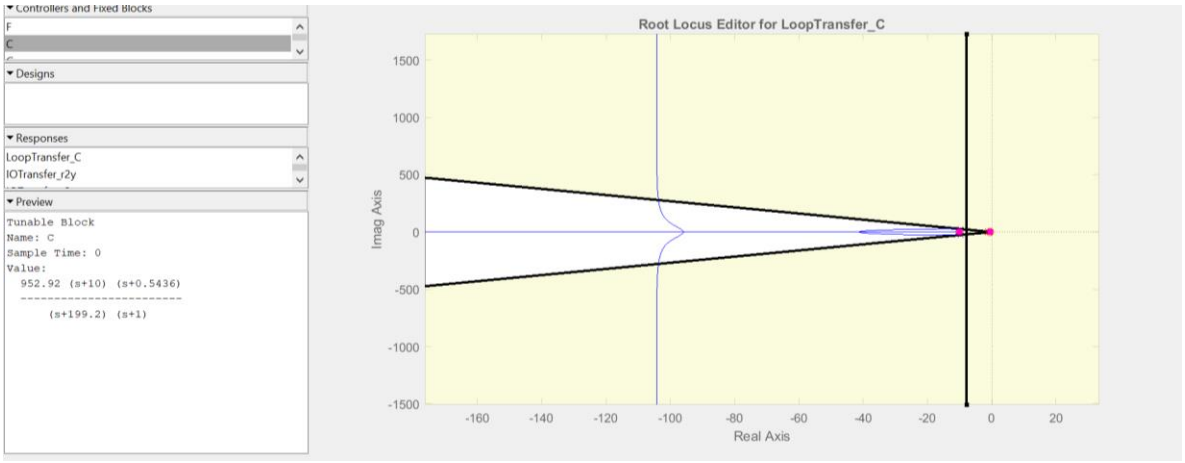
Lag Compensator




```
C4Lag =

  26 (s+10) (s+0.5436)
  --------------------
     (s+141) (s+1)

Continuous-time zero/pole/gain model.
```




1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2


Controllers and Fixed Blocks
F
C
Designs
Responses
LoopTransfer_C
IOTransfer_r2y
Preview
Tunable Block
Name: C
Sample Time: 0
Value:
952.92 (s+10) (s+0.5436)
(s+199.2) (s+1)
Root Locus Editor for LoopTransfer_C
Imag Axis
Real Axis
1500
1000
500
0
-500
-1000
-1500
-160
-140
-120
-100
-80
-60
-40
-20
0
20

System5

{n = 21}

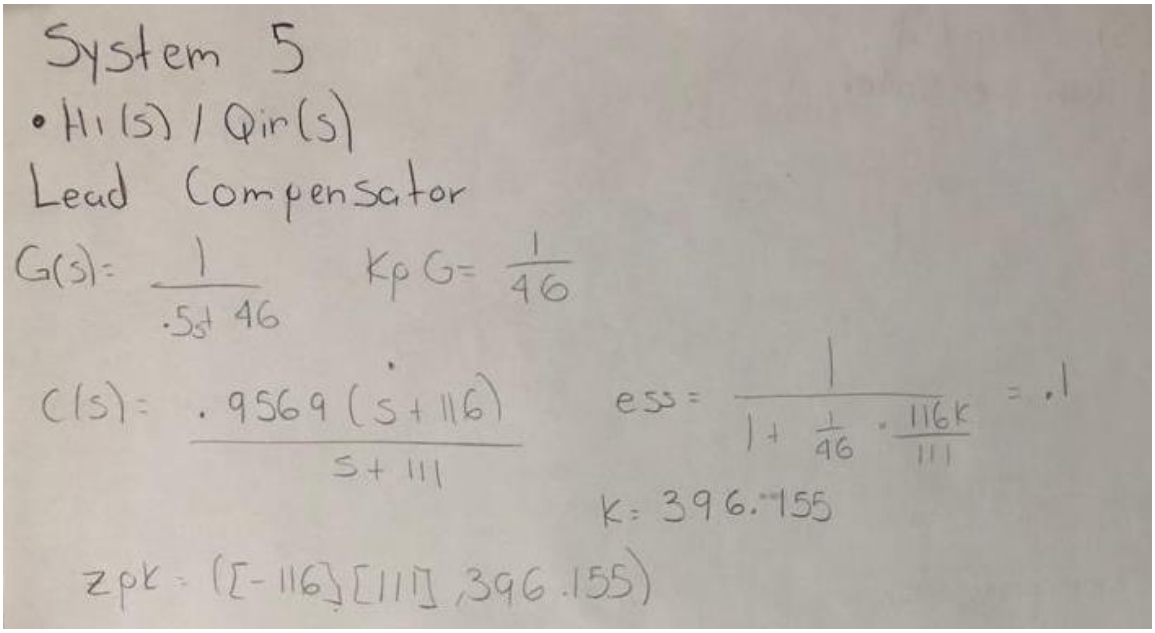
Tank 1

Symbolic transfer function

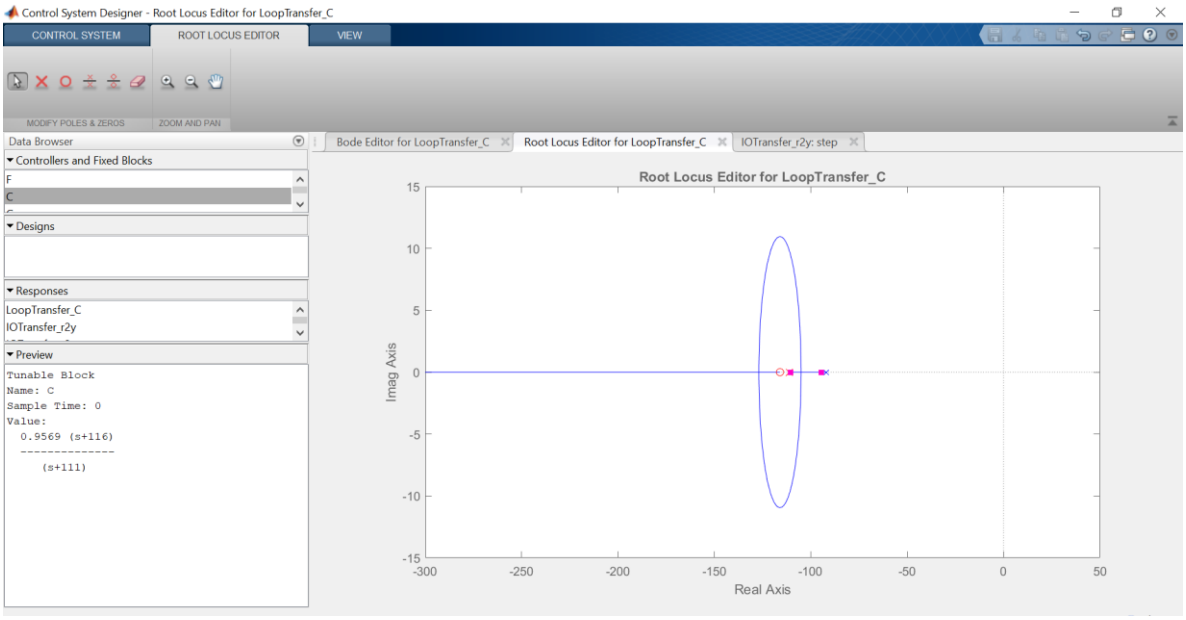
$$\frac{1}{Area1 + \frac{s}{R1}}$$

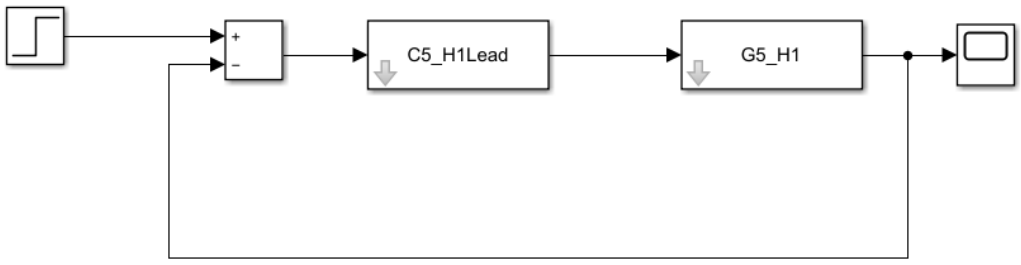
```
G5_H1 =

      1
  ----------
  0.5 s + 46

Continuous-time transfer function.
```

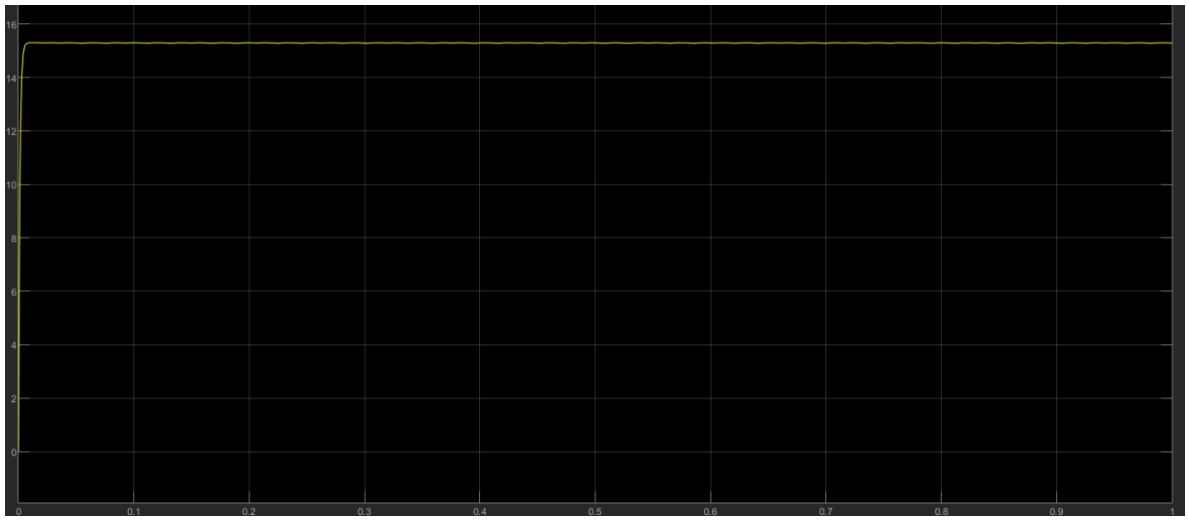
Lead Compensator



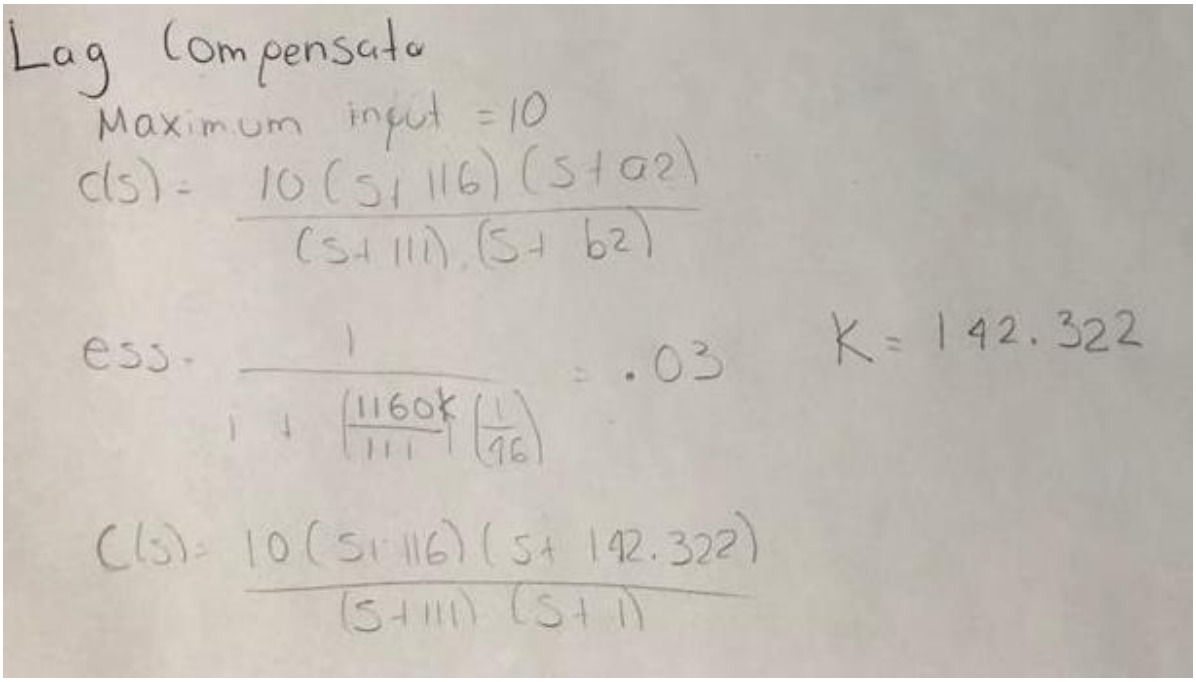
```
C5_H1Lead =

  396.15 (s+116)
  --------------
     (s+111)

Continuous-time zero/pole/gain model.
```



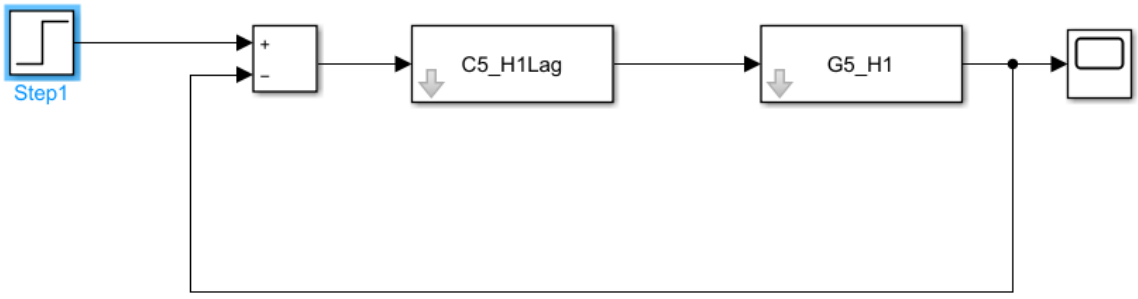


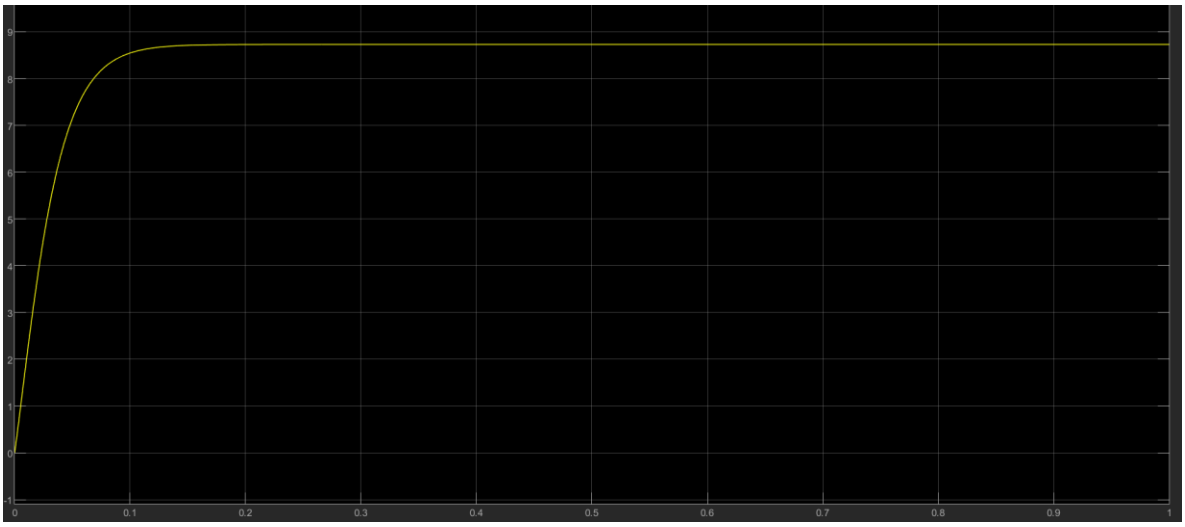


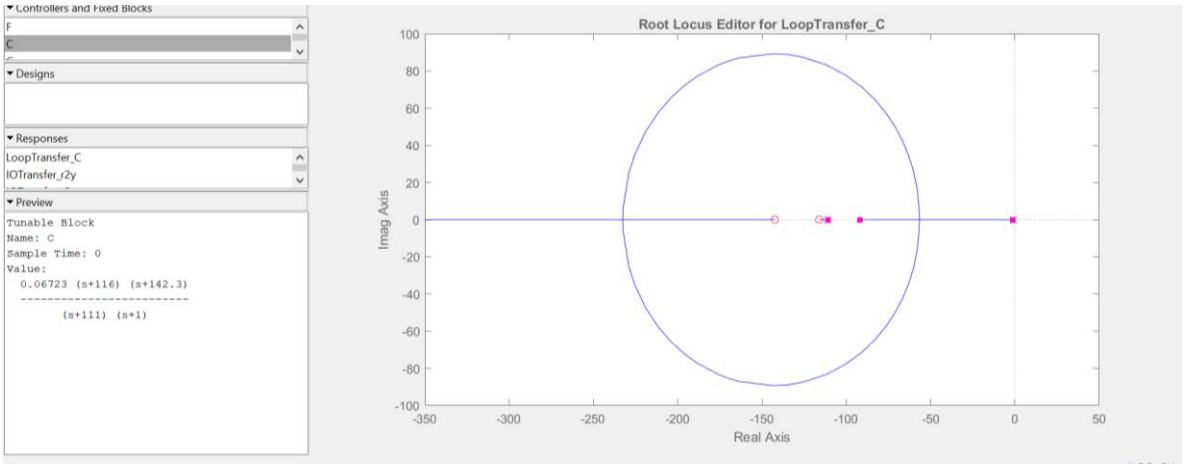
Lag Compensator




```
C5_H1Lag =

  10 (s+116) (s+142.3)
  --------------------
     (s+111) (s+1)

Continuous-time zero/pole/gain model.
```


Step1
+
−
C5_H1Lag
G5_H1


9
8
7
6
5
4
3
2
1
0
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Controllers and Fixed Blocks
F
C
Designs
Responses
LoopTransfer_C
IOTransfer_r2y
Preview
Tunable Block
Name: C
Sample Time: 0
Value:
0.06723 (s+116) (s+142.3)
(s+111) (s+1)
Root Locus Editor for LoopTransfer_C
Imag Axis
Real Axis
100
80
60
40
20
0
-20
-40
-60
-80
-100
-350
-300
-250
-200
-150
-100
-50
0
50

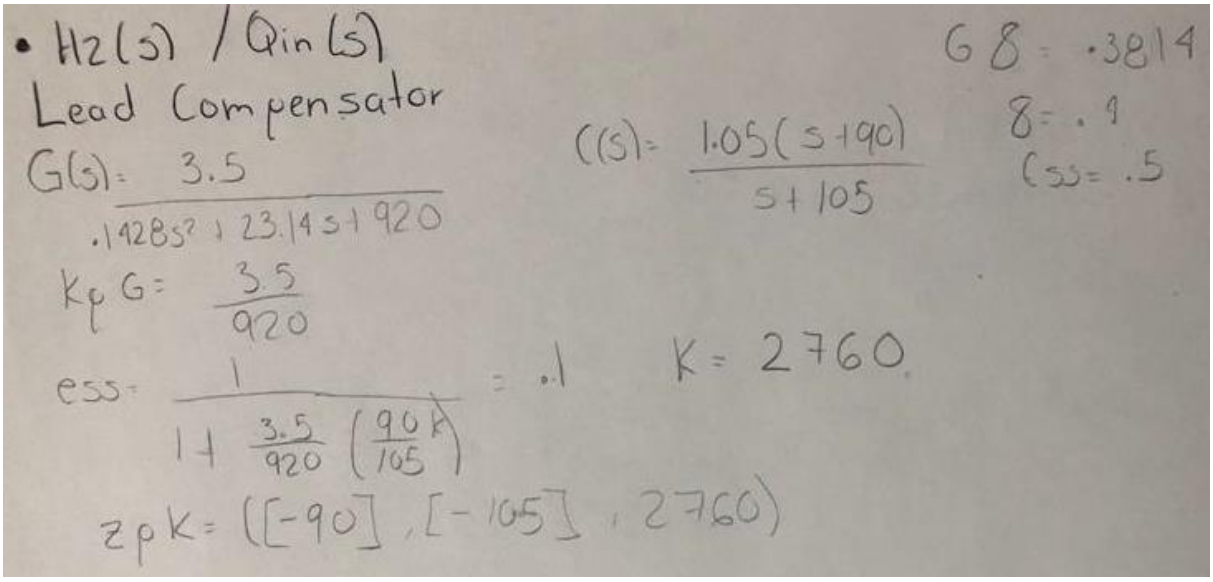
Tank 2

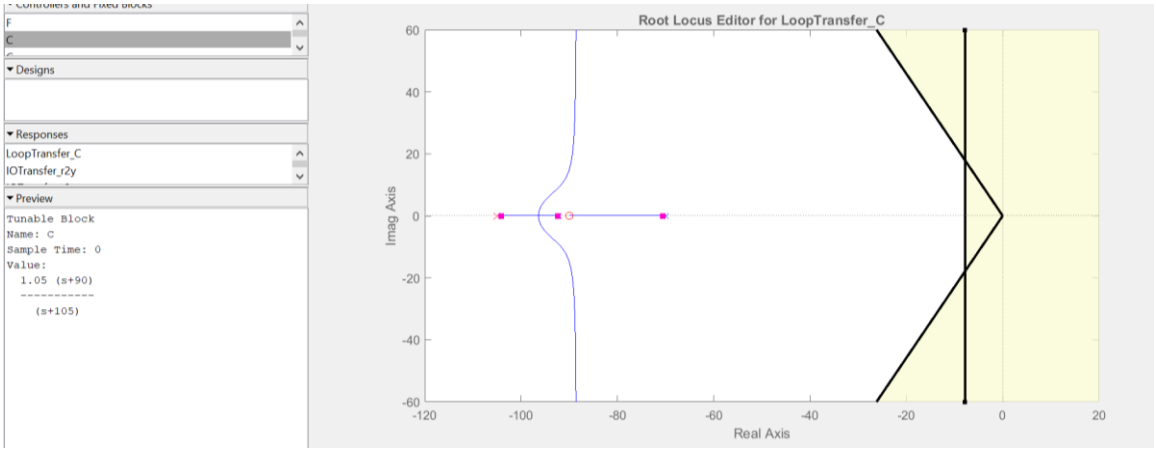
Symbolic transfer function

$$\frac{Qin1}{\frac{A2s}{R1} + A2A1 + \frac{s^2}{R1R2} + \frac{A1s}{R2}}$$

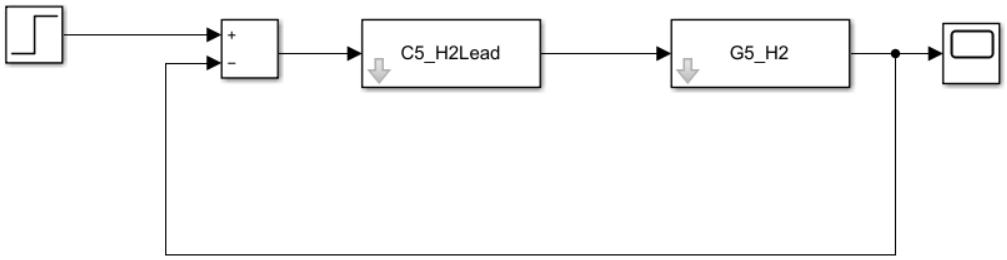
```
G5_H2 =

             3.5
  -------------------------
  0.1428 s^2 + 23.14 s + 920

Continuous-time transfer function.
```

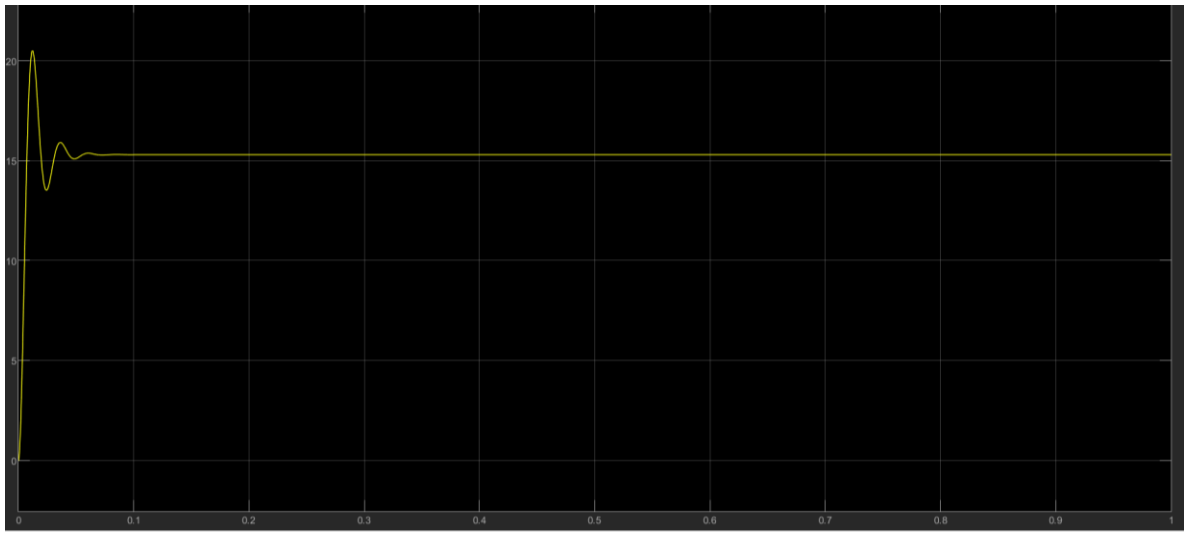
Lead Compensator



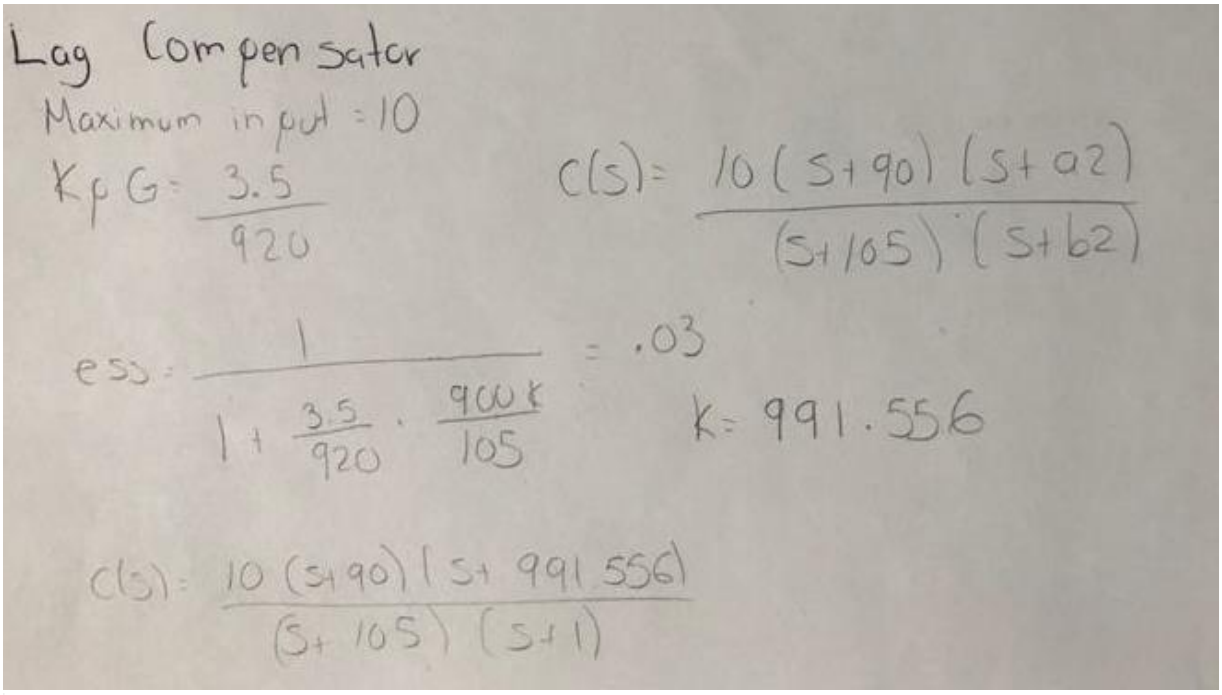



```
C5_H2Lead =

  2760 (s+90)
  -----------
    (s+105)

Continuous-time zero/pole/gain model.
```

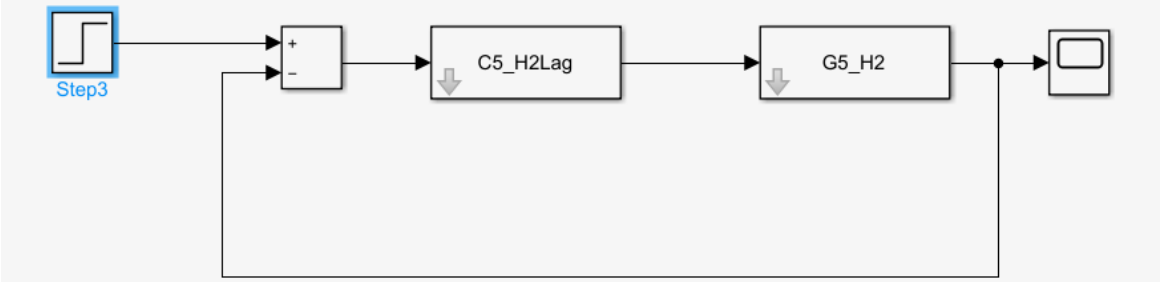


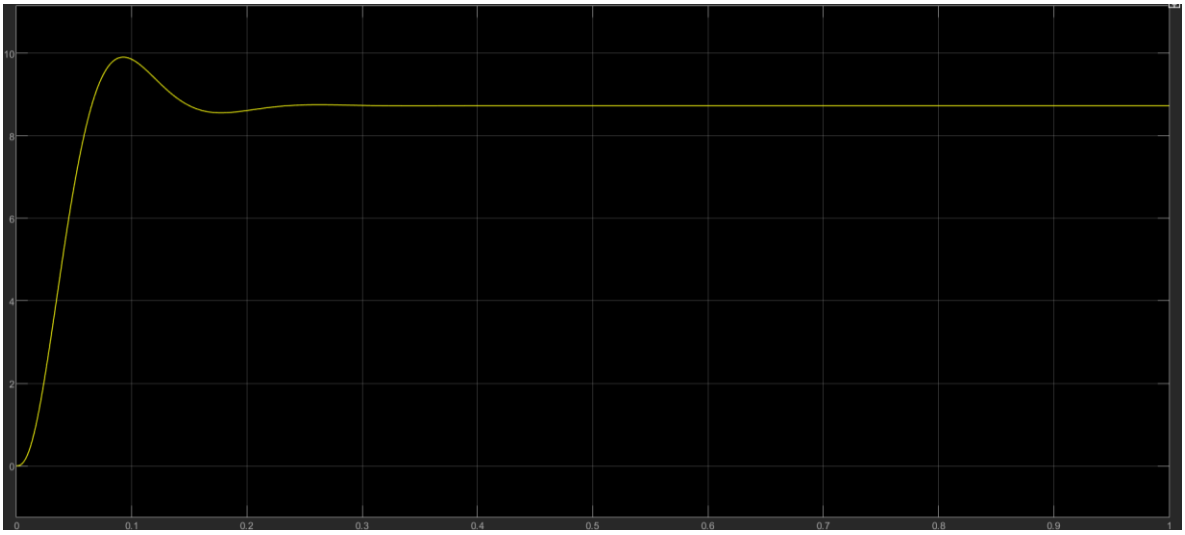


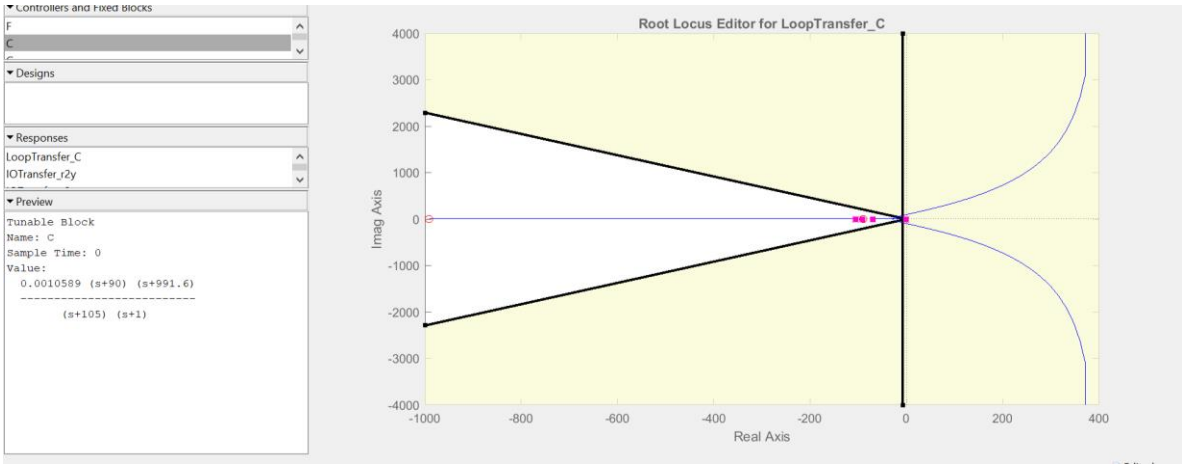
Lag Compensator




```
C5_H2Lag =

  10 (s+90) (s+991.6)
  -------------------
     (s+105) (s+1)

Continuous-time zero/pole/gain model.
```


Step3
+
−
C5_H2Lag
G5_H2


10
8
6
4
2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Controllers and Fixed Blocks
F
C
Designs
Responses
LoopTransfer_C
IOTransfer_r2y
Preview
Tunable Block
Name: C
Sample Time: 0
Value:
0.0010589 (s+90) (s+991.6)
(s+105) (s+1)
Root Locus Editor for LoopTransfer_C
Imag Axis
Real Axis
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-1000
-800
-600
-400
-200
0
200
400