EENG 5170 Control and Mechatronics

Homework Assignment - 1

Q1 Use Matlab to find the roots of the following polynomials:

Code:

```
a ▸ Desktop ▸ Matlab assignment Lab 2 EENG5650
Editor - C:\Users\kgaga\Desktop\Matlab assignment Lab 2 EENG5650\EENG_5170_HW_1.m
EENG_5170_HW_1.m  ×  EENG_5170_HW_2.m  ×  EENG_5170_HW_3.m  ×  +

clc %clear screen
%EENG 5170 HW Assignment 1
% Q1. a
p1 =[2 -3 4 -1 3 0];%polynomial expression
r1 = roots(p1) ;%roots
disp("Roots for P1 = ")
disp(r1)

%Q1. b
p2 =[-1,0,0,5,-1,0,10];%polynomial expression
r2 = roots(p2);%roots
disp("Roots for P2 = ")
disp(r2)

%Q2
```

Result:

```
Editor - C:\Users\kgaga\Desktop\Matlab assignment Lab 2 EENG5650\EENG_5170_
EENG_5170_HW_1.m  ×  EENG_5170_HW_2.m  ×  EENG_5170_HW_3.m  ×

clc %clear screen
%EENG 5170 HW Assignment 1
% Q1. a
p1 =[2 -3 4 -1 3 0];%polynomial expression
r1 = roots(p1) ;%roots
disp("Roots for P1 = ")
disp(r1)

%Q1. b
p2 =[-1,0,0,5,-1,0,10];%polynomial expression
r2 = roots(p2);%roots
disp("Roots for P2 = ")
disp(r2)
```

```
Command Window
Roots for P1 =
   0.0000 + 0.0000i
   0.9602 + 1.0805i
   0.9602 - 1.0805i
  -0.2102 + 0.8208i
  -0.2102 - 0.8208i

Roots for P2 =
   1.8265 + 0.0000i
  -0.9753 + 1.6199i
  -0.9753 - 1.6199i
   0.6180 + 0.9977i
   0.6180 - 0.9977i
  -1.1119 + 0.0000i
```

Q2 Use Matlab to find the poles and zeros of the following transfer function:

Code:

Editor - C:\Users\kgaga\Desktop\Matlab assignment Lab 2 EENG5650\EENG_5170_H

EENG_5170_HW_1.m | EENG_5170_HW_2.m | EENG_5170_HW_3.m

```
% Q2
clc
num1 = [1 5 -7];% s^2 + 5s - 7
den1 = [1 -1 2 -5 2]; % s^4 -s^3 - 5s +2
sys1 = tf(num1,den1);
p = pole(sys1);% pole values
z = zero(sys1);%zero values
disp("Poles ="); disp(p)
disp("Zeros ="); disp(z)
pzmap(sys1)
```

Result:

Editor - C:\Users\kgaga\Desktop\Matlab assignment Lab 2 EENG5650\

EENG_5170_HW_1.m | EENG_5170_HW_2.m | EENG_5170_H

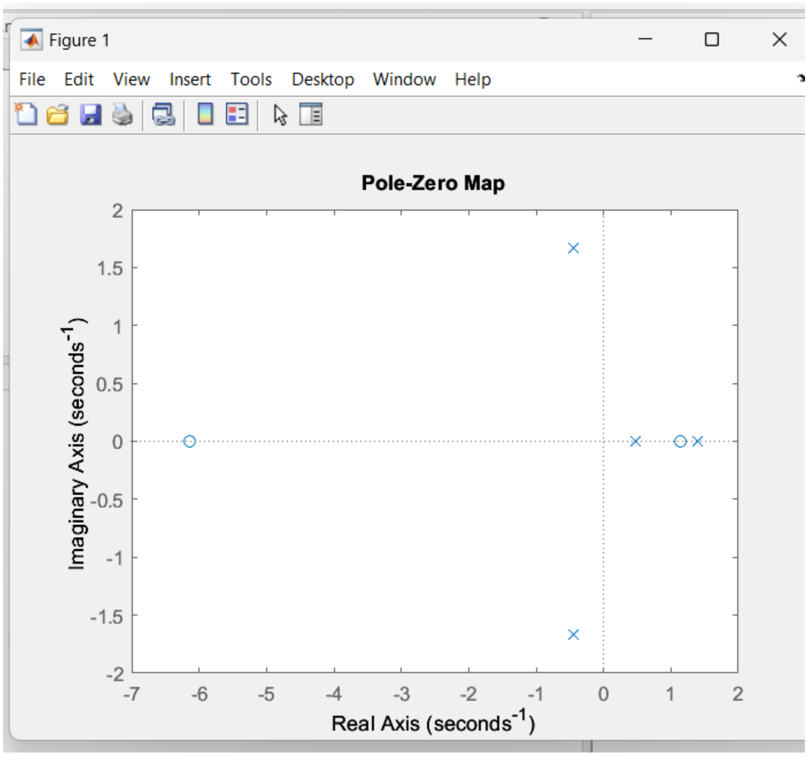
```
% Q2
clc
num1 = [1 5 -7];% s^2 + 5s - 7
den1 = [1 -1 2 -5 2]; % s^4 -s^3 - 5s +2
sys1 = tf(num1,den1);
p = pole(sys1);% pole values
z = zero(sys1);%zero values
disp("Poles ="); disp(p)
disp("Zeros ="); disp(z)
pzmap(sys1)
```


Command Window

```
Poles =
  -0.4389 + 1.6685i
  -0.4389 - 1.6685i
   1.3969 + 0.0000i
   0.4810 + 0.0000i

Zeros =
   -6.1401
    1.1401
```

Plot:



Q3

Code:

Desktop ▸ Matlab assignment Lab 2 EENG5650

Editor - C:\Users\kgaga\Desktop\Matlab assignment Lab 2 EENG5650\EENG_5170_HW_3.m

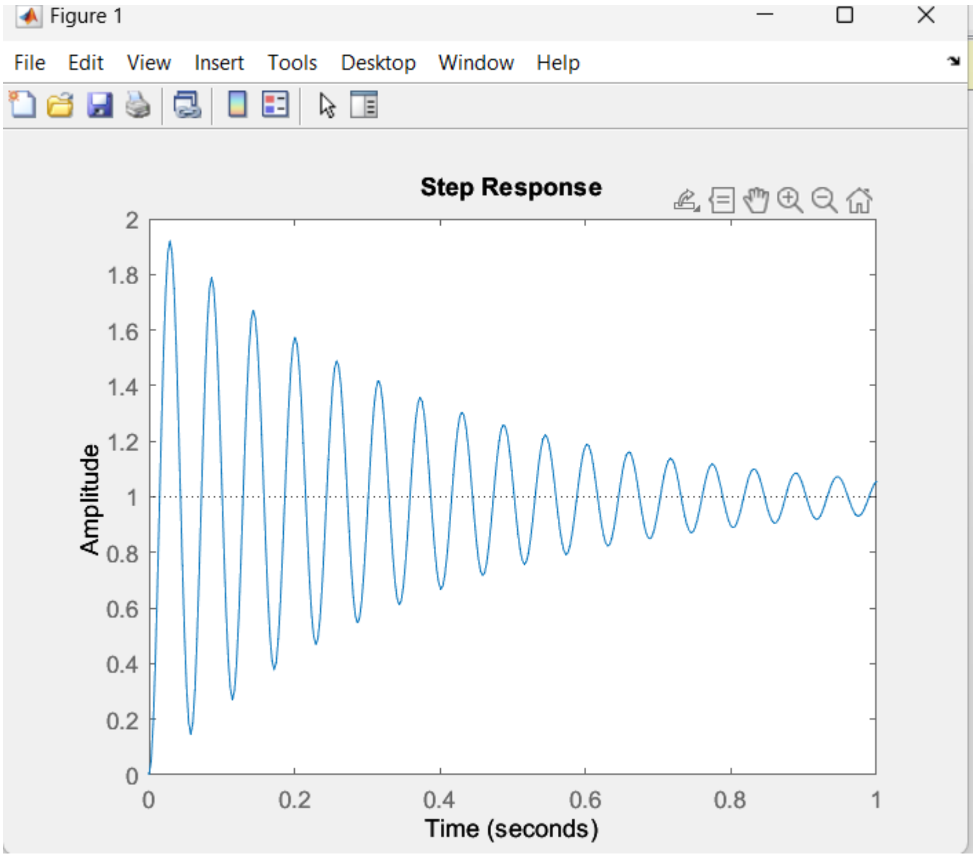
EENG_5170_HW_1.m | EENG_5170_HW_2.m | EENG_5170_HW_3.m

```
%EENG 5170 Q3
clc
g1 = tf([20],[1,2]);
g2 = tf([1], [1,3.5]);
sys1 = g1*g2;
sys1_1 = feedback(sys1, 0.2, -1);
g3 = 600;
sysR = g3*sys1_1;
sys = feedback(sysR, 1, -1);
step(sys, 1);
```

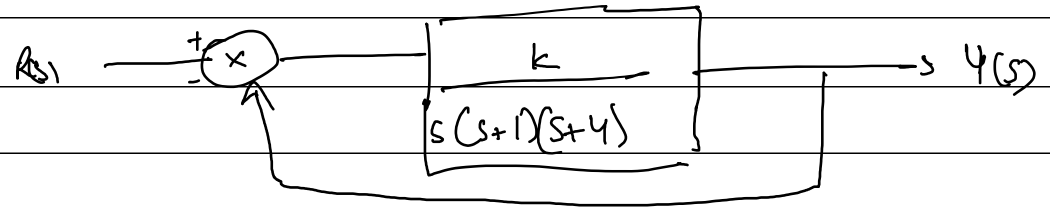
Workspace:

Name	Value
den1	[1,-1,2,-5,2]
g1	1x1 tf
g2	1x1 tf
g3	600
num1	[1,5,-7]
out	1x1 SimulationOutput
p	[-0.4389 + 1.6685i;-0.4389 - 1.668...
p1	[2,-3,4,-1,3,0]
p2	[-1,0,0,5,-1,0,10]
r1	[0.0000 + 0.0000i;0.9602 + 1.0805i...
r2	[1.8265 + 0.0000i;-0.9753 + 1.619...
sys	1x1 tf
sys1	1x1 tf
sys1_1	1x1 tf
sysR	1x1 tf
z	[-6.1401;1.1401]

Plot:



Q4:



a] Closed loop transfer function.

$E(s) = R(s) - B(s) = R(s) - Y(s)$ $\quad Y(s) = G(s) \cdot E(s)$

$\therefore \frac{Y(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)}$ $\quad H(s) = 1$

$\therefore \frac{Y(s)}{R(s)} = \frac{\frac{K}{s(s+1)(s+4)}}{1 + \frac{k}{s(s+1)(s+4)}} = \frac{k}{(s)(s+1)(s+4) + k}$

$\therefore \frac{Y(s)}{R(s)} = \frac{k}{s^3 + 5s^2 + 4s + k}$

b] Routh - Hurwitz Stability Criterian

$a_n > 0 = 1$ $\quad a_0 \neq = k$ $\quad D(s) = s^3 + 5s^2 + 4s + k$

$\therefore$ Routh Table

s^3	1	4
s^2	5	k
	$\frac{20-k}{5}$	0
	k	

$\therefore$

$c_1 = -\left[\frac{k - 20}{5}\right]$

$c_2 = -\left[\frac{0 - 0}{5}\right]$

$d_1 = -\left[\frac{0 - k\left(\frac{20-k}{5}\right)}{\left(\frac{20-k}{5}\right)}\right]$

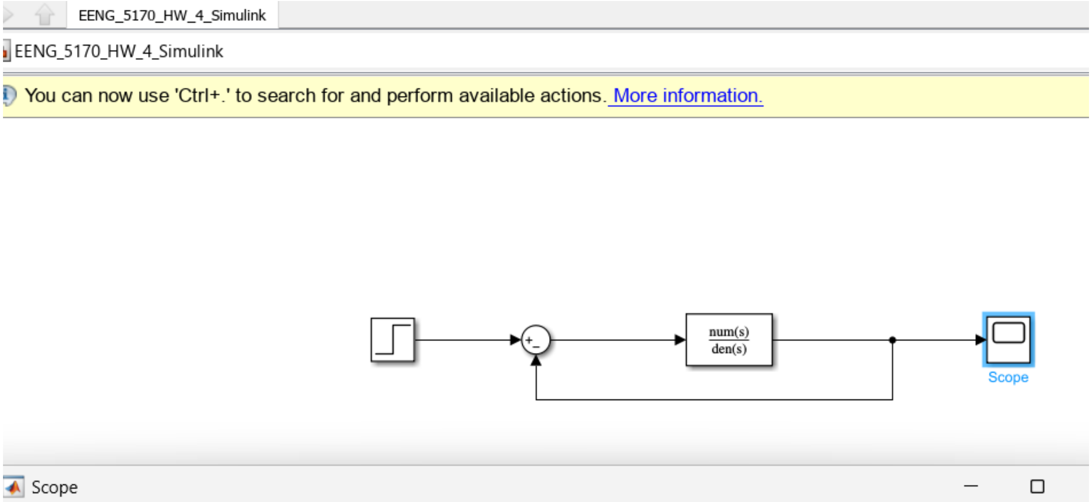
No sign change in 1st column

$\therefore \frac{20-k}{5} > 0$ $\quad \therefore k > 0$

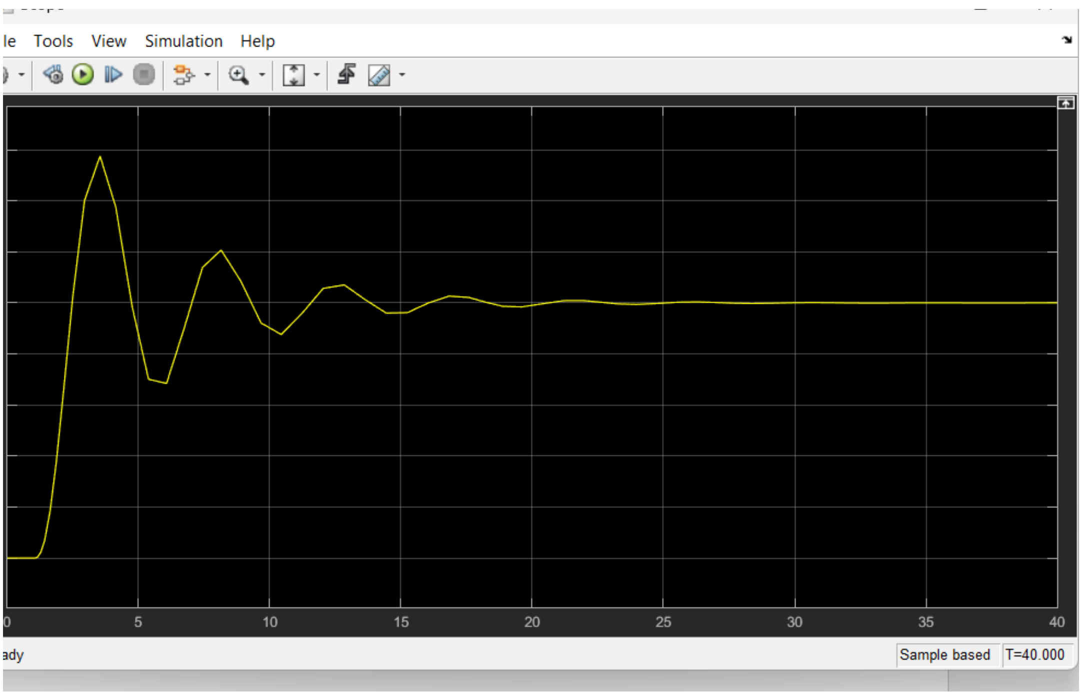
$\therefore$ System is stable if

$0 < k < 20$

Simulink:



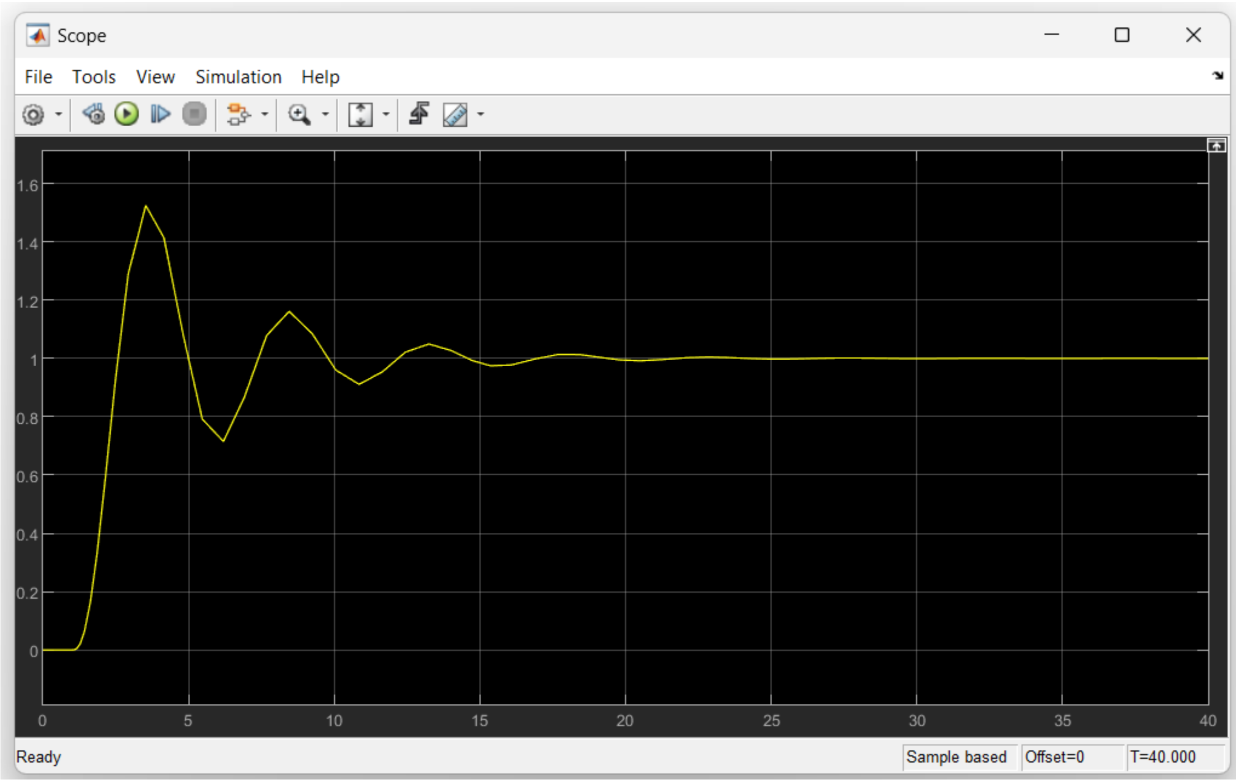
For k = 3: t = 40



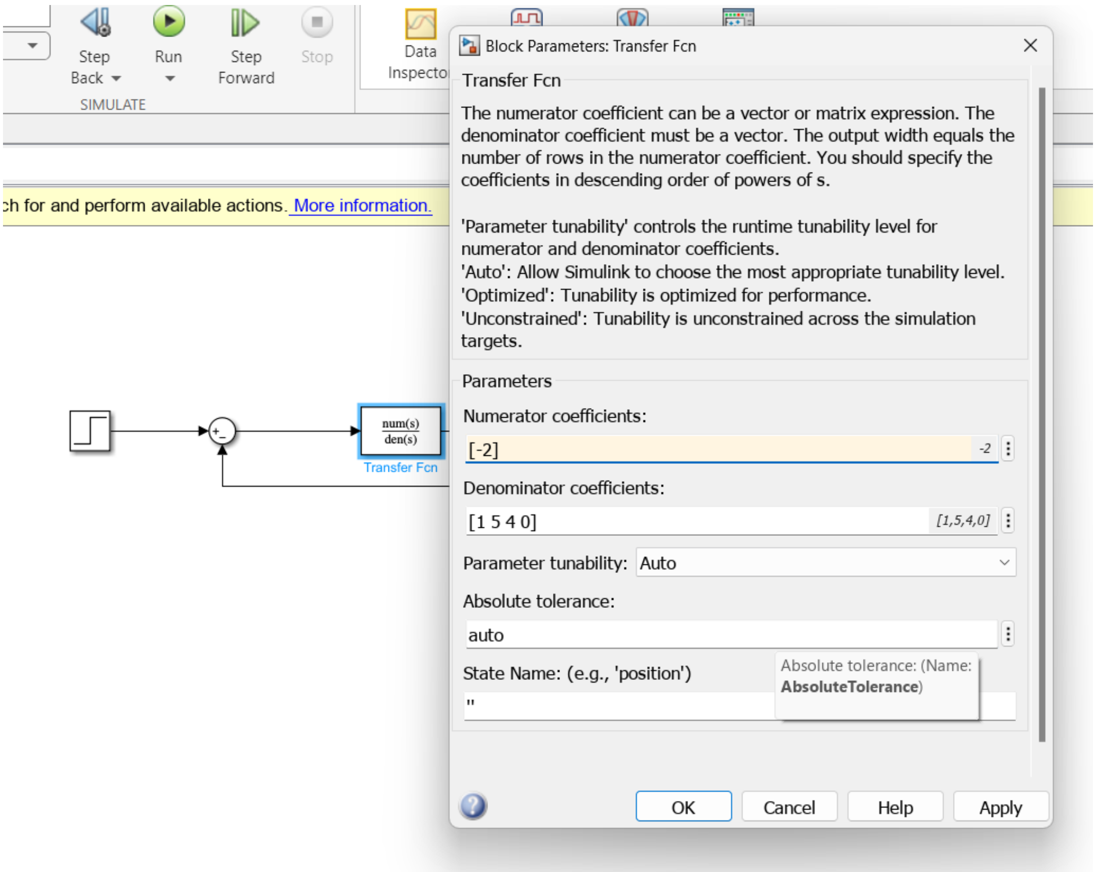
Stable!

For k = 8 t = 40

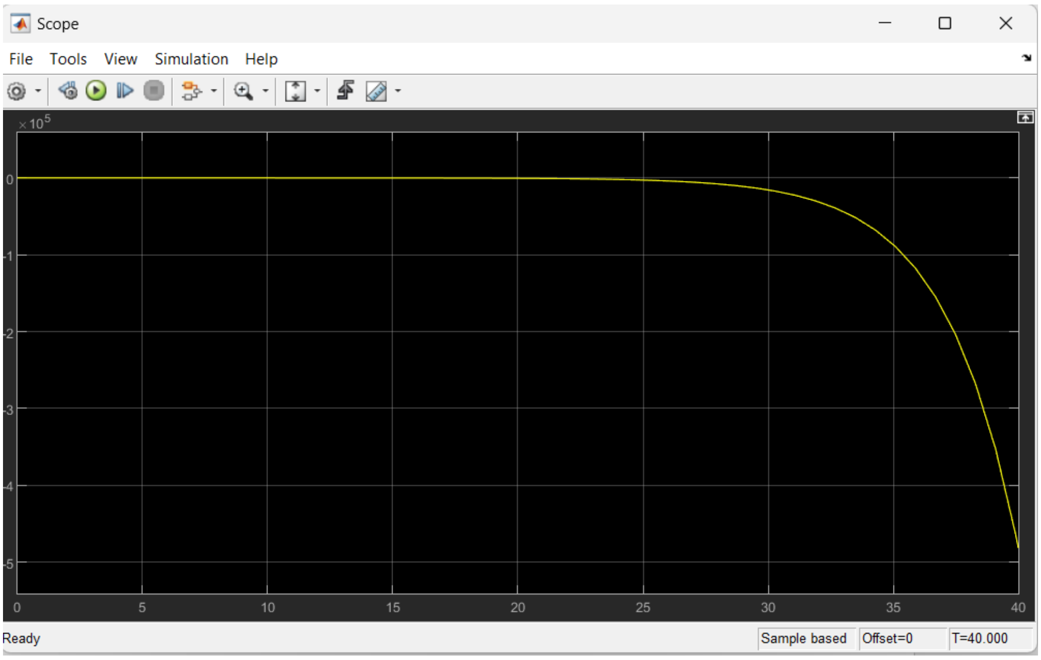
Stable!



k = -2 t = 40



Not stable



K = 23 t = 40

Not stable