KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING

DHULIKHEL

PCEG-308

Lab -03

Time Response of Systems

Department of Electrical and Electronics Engineering

By:

Samyam Shrestha (32056)

To:

Dr. Sujan Adhikari

Date:

27th June, 2024

Time Response of the Systems

Step Response of the system

1) **Determine the step response of the unity feedback control system having forward path transfer G(s) = $\frac{(2s+4)}{s(2s+1)}$**

```
>> [n1] = [2 , 4];
>> [d1] = [2, 1, 0];
>> [n2, d2] = feedback(n1,d1,1,1);
>> printsys(n2,d2)

num/den =

     2 s + 4
  ---------------
   2 s^2 + 3 s + 4
>> step(n2,d2)
>> grid;
>> xlabel('Time');
>> ylabel('Magnitude');
```

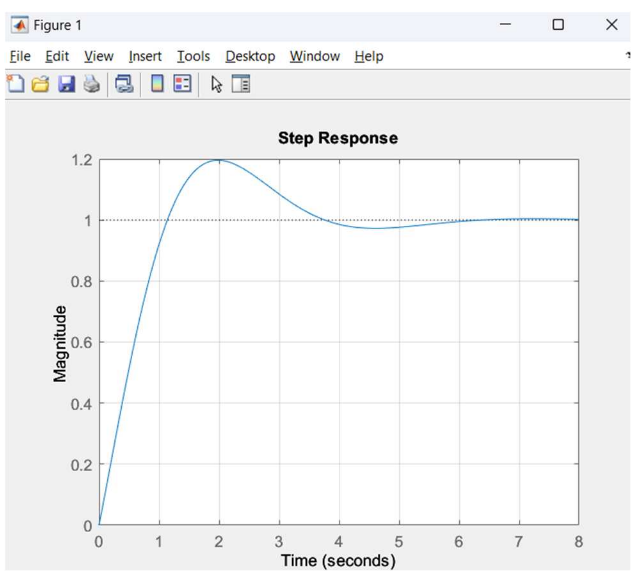


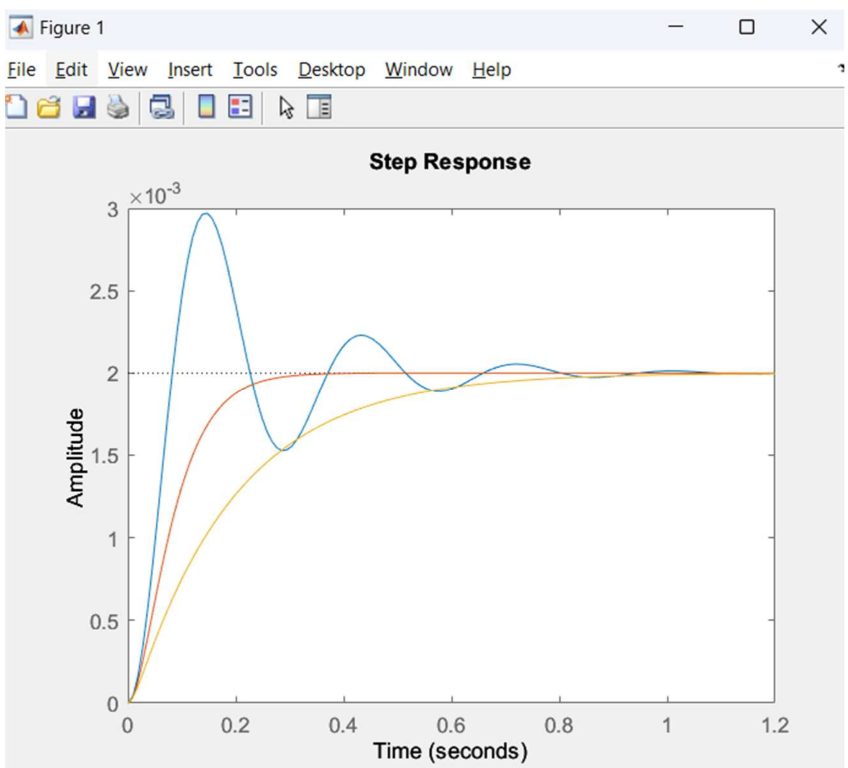
Figure 1: Step Response

2) **Consider the second order system given by the equation**

$$M \cdot d^2x / dt^2 + b \cdot dx / dt + K \cdot x = F(t)$$

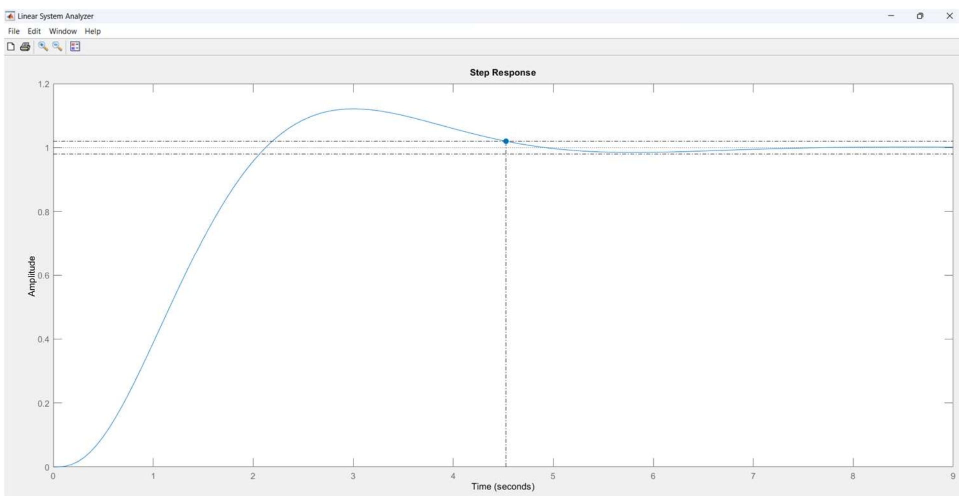
Below is the MATLAB code for the visualization of the response of the second order of the system.

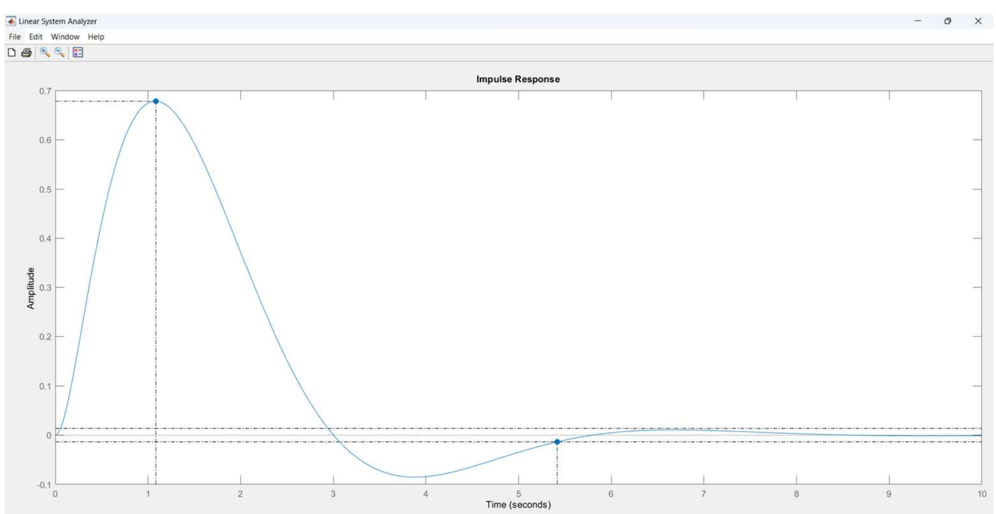
```
>> m = 1;
>> b = 10;
>> k = 500;
>> num = [0 0 1];
>> den = [m b k];
>> step (num , den)
>> hold on;
>> b = 44.7;
>> den = [m b k];
>> step (num, den)
>> hold on;
>> b = 100;
>> den = [m b k];
>> step(num, den)
```



Use of LTI viewer

```
>> n1 = [10];
>> d1 = [1 7 10 10];
>> sys1 = tf(n1, d1);
>> sys1 = tf(n1, d1)

sys1 =

         10
  ----------------------
  s^3 + 7 s^2 + 10 s + 10

Continuous-time transfer function.

>> ltiview(sys1)
```

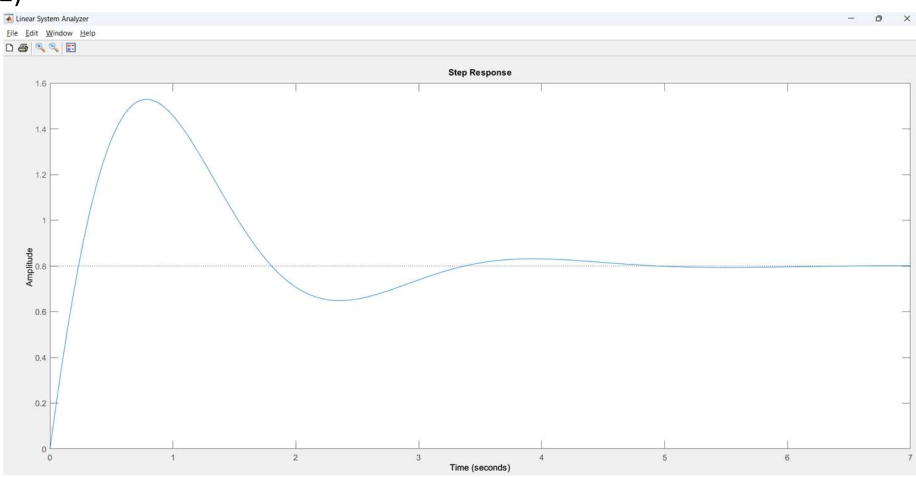


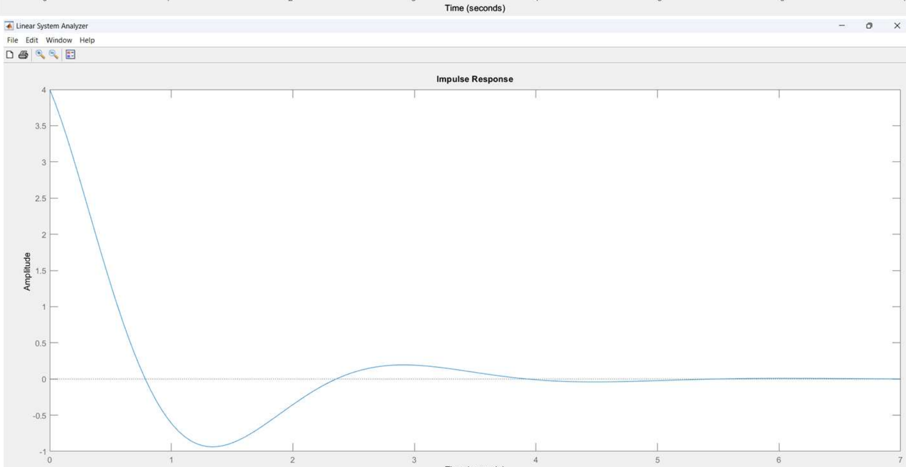


Similarly, for the transfer function TF2 = G(s) = $\frac{4s+4}{s^2+2s+5}$

Matlab Code:

```
>> n1 = [4 4];
>> d1 = [1 2 5];
>> sys2 = tf(n1, d1)

sys2 =

    4 s + 4
  -------------
  s^2 + 2 s + 5

Continuous-time transfer function.

>> ltiview(sys2)
```





Ramp Response

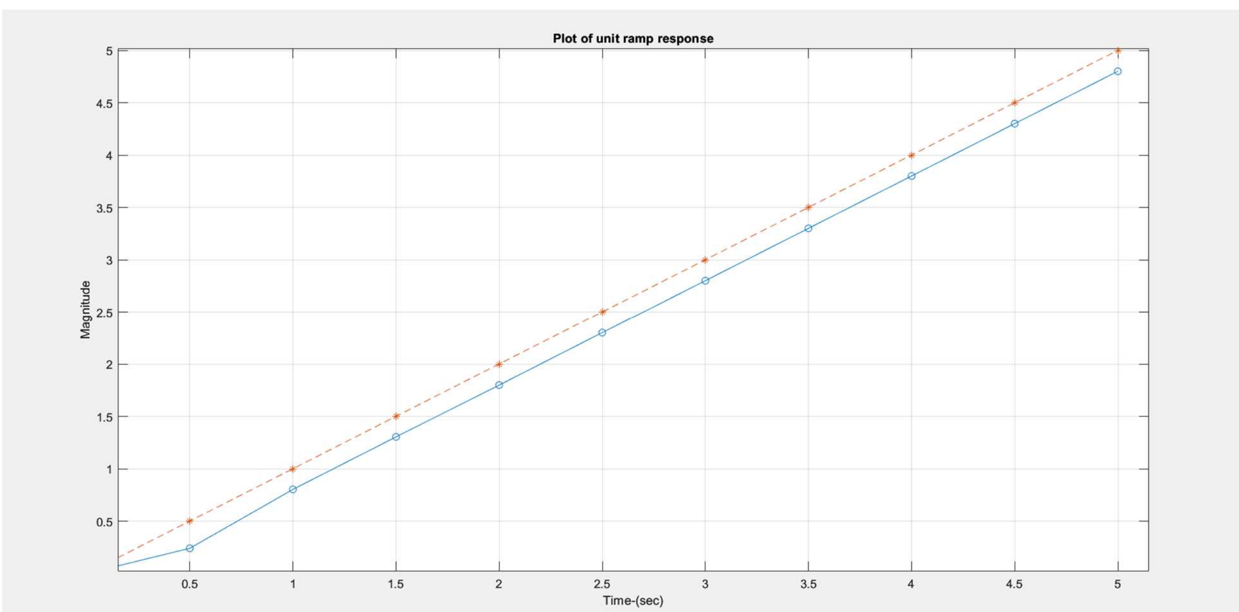
Ramp response is obtained by dividing the transfer function by s.

Obtain the ramp response of the control system having the transfer function

$$G(s) = \frac{25}{s^2 + 5s + 25}$$

Matlab Code:

```
>> n1 = [25];
>> d1 = [1 5 25 0];
>> sys1 = tf(n1, d1);
>> t = 0 :0.5 :5;
>> y = step(sys1, t);
>> plot(t,y, '-o');
>> axis([0 5 0 5]);
>> hold on;
>> plot(t, t, '--*');
>> grid on;
>> xlabel('Time-(sec)');
>> ylabel('Magnitude');
>> title('Plot of unit ramp response');
```

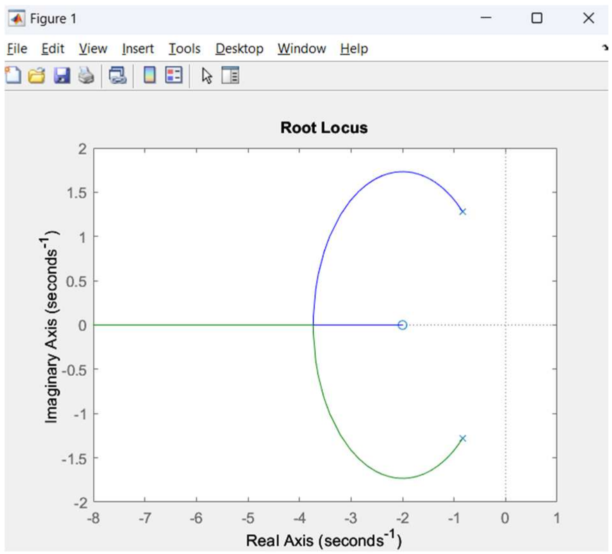


Root Locus

Plot the root locus for the system whose open loop transfer function is given as:

$$G(s)H(s) = \frac{K(s+2)}{(3s^2+5s+7)}$$

```
>> n1 = [1 2];
>> d1 = [3 5 7];
>> rlocus(n1, d1)
```



Plot the root locus and examine the stability of the system whose open loop transfer function is given as:

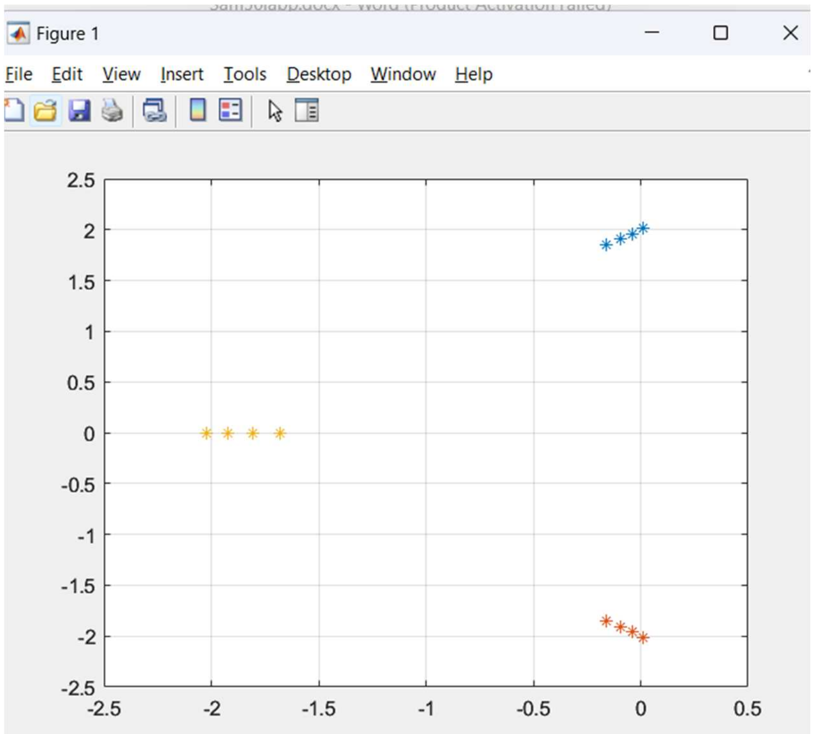
$$G(s)H(s) = \frac{0.4K}{s^3+2s^2+4s+5}$$

If the gain K is varied over a range of: K = 2, 4, 6, 8. Determine the exact pole locations also in tabular form.

```
>> k = 2:2:8;
>> n1 = [0.4];
>> d1 = [1 2 4 5];
>> [r, k] = rlocus(n1,d1,k);
>> plot(r, '*');
>> grid;
>> [r, k] = rlocus(n1, d1, k)

r =

  -0.1615 + 1.8527i  -0.1615 - 1.8527i  -1.6771 + 0.0000i
  -0.0963 + 1.9085i  -0.0963 - 1.9085i  -1.8073 + 0.0000i
  -0.0390 + 1.9618i  -0.0390 - 1.9618i  -1.9220 + 0.0000i
   0.0123 + 2.0124i   0.0123 - 2.0124i  -2.0247 + 0.0000i
```

k =

    2   4   6   8



For the transfer function is given below plot the root locus and find the value of K for the damping ratio $\xi = 0.5$.

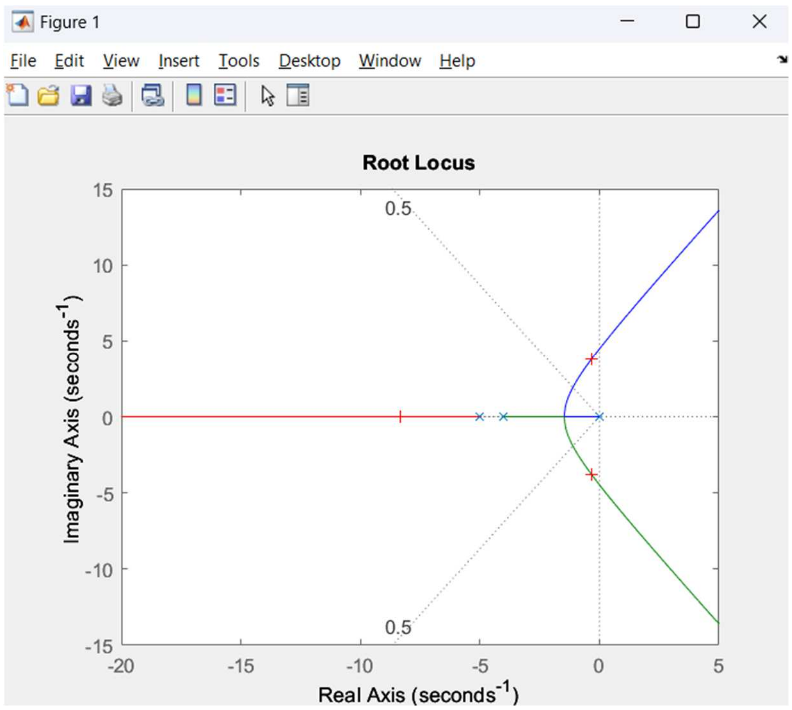
$$G(s)H(s) = \frac{K}{s(s+4)(s+5)}$$

```
>> n = 1;
>> d = conv([1 0], conv([1 4], [1 5]));
>> rlocus(n,d);
>> sgrid(0.5, []);
>> [k,r] = rlocfind(n,d)
Select a point in the graphics window

selected_point =

  -0.5161 - 3.8710i


k =
```

120.4748

r =

-8.3347 + 0.0000i
-0.3327 + 3.7873i
-0.3327 - 3.7873i



3. Plot the root locus for the system whose open loop transfer functions are given below, also fir the value of K for the damping ratio $\xi = 0.5$. Comment on the stability of the system.

(a) $G(s)H(s) = \frac{K}{s(s^2+7s+20)}$

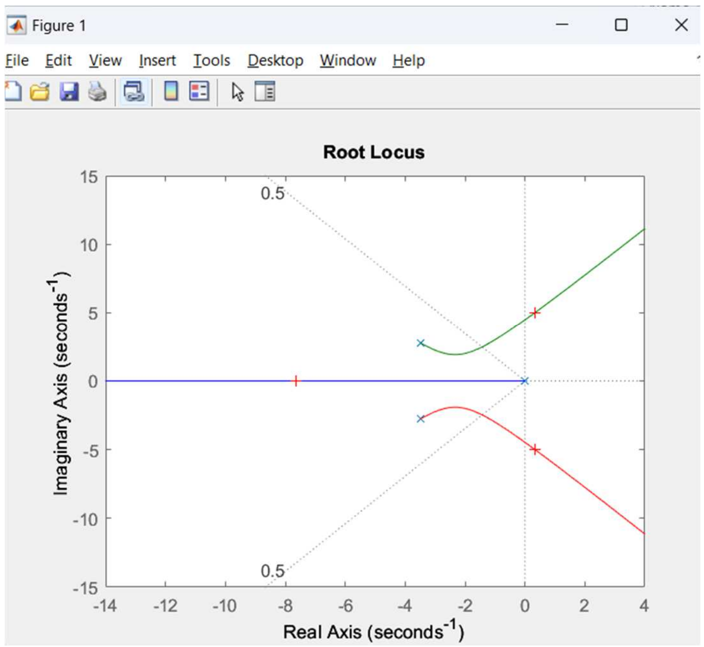
(b) $G(s)H(s) = \frac{K(2s+9)}{s(s^2+6s+13)}$

(c) $G(s)H(s) = \frac{K}{(s^2+3s+2)(s^2+2s+5)}$

a) Matlab Code:

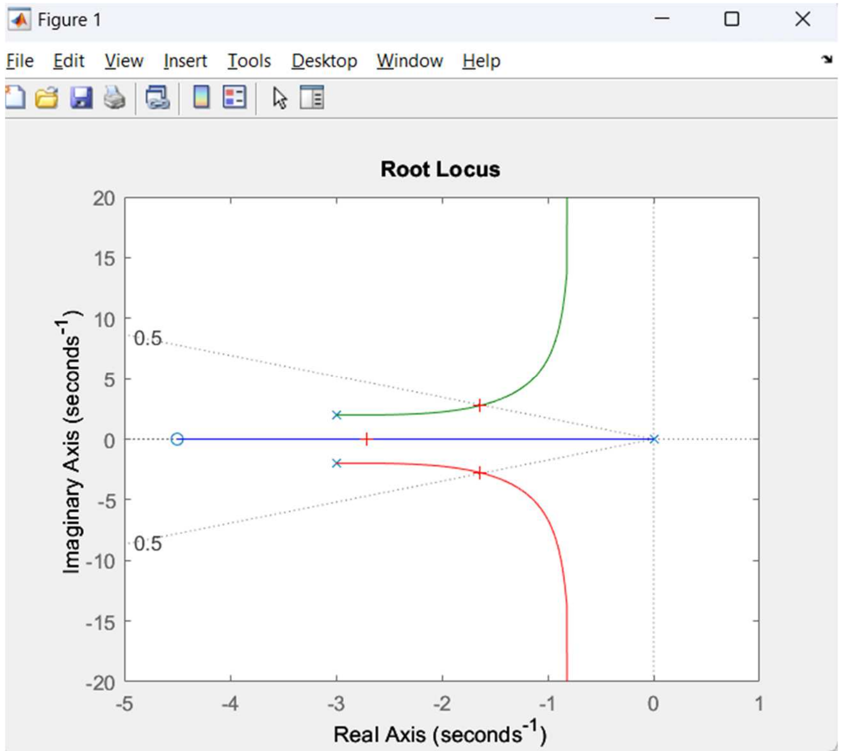
```
>> n = [1];
>> d = [1 7 20 0];
>> rlocus(n, d);
>> sgrid(0.5 , []);
>> [k, r]= rlocfind(n,d)
Select a point in the graphics window
```

selected_point = 0.3352 + 4.9876i
k = 191.6227
r =
  -7.6566 + 0.0000i
   0.3283 + 4.9919i
   0.3283 - 4.9919i



b) Matlab Code

```
>> n = [ 2 9];
>> d = [1 6 13 0];
>> rlocus (n , d);
>> sgrid(0.5, []);
>> [k, r] =rlocfind(n,d)
Select a point in the graphics window
selected_point = -1.7216 - 2.7792i
k =    3.0808
r =
  -1.6472 + 2.7450i
  -1.6472 - 2.7450i
  -2.7055 + 0.0000i
```



c) Matlab Code:

```
>> n = 1;
>> d = conv([1 3 2], [1 2 5]);
>> rlocus(n,d);
>> sgrid(0.5, []);
>> [k,r] = rlocfind(n, d)
Select a point in the graphics window
selected_point = -4.5625 + 3.4739
k = 540.8640
r =
  -4.5232 + 3.5163i
  -4.5232 - 3.5163i
   2.0232 + 3.5621i
   2.0232 - 3.5621i
```