EGE UNIVERSITY
ELECTRICAL AND ELECTRONICS ENGINEERING

CONTROL SYSTEMS 1

LAB-7

MUSA OĞURAL
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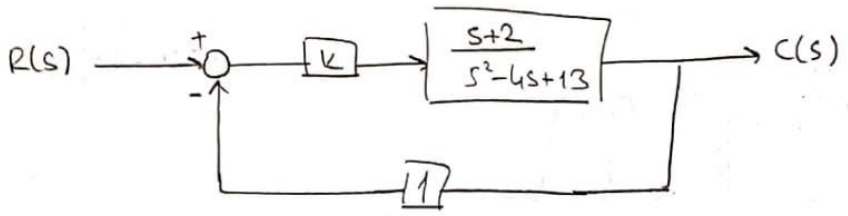
Control Lab-7



Köklerin yer eğrisini çiziniz

$s^2-4s+13=0 \longrightarrow s_{1,2}=2\pm j3 \longrightarrow P_{1,2}=2\pm j3$

$s+2=0 \;,\; s=-2 \longrightarrow z=-2$

→ Sanal ekseni kestiği noktalar

$$G_{CL}=\frac{K(s+2)}{s^2+(K-4)s+2K+13}$$

$Q(s)=s^2+(K-4)s+2K+13 \longrightarrow K=4 \longrightarrow Q(s)=s^2+21$

$s_{1,2}=\pm j\sqrt{21}$

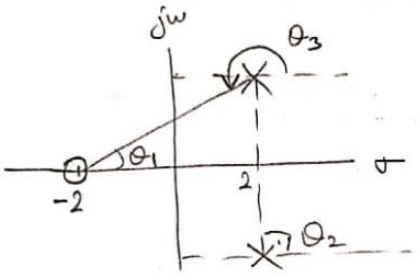
→ Reel eksende birleşme noktaları

$$G_{CL}=\frac{KGH}{1+KGH} \;,\; 1+KGH=0 \longrightarrow K=-\frac{1}{GH}$$

$$K=-\frac{(s^2-4s+13)}{s+2} \;,\; \frac{dK}{ds}=-\frac{(s^2-4s-21)}{(s+2)^2}=0$$

$s=3 \;,\; s=-7$

→ Komplex köklerin gidiş açıları

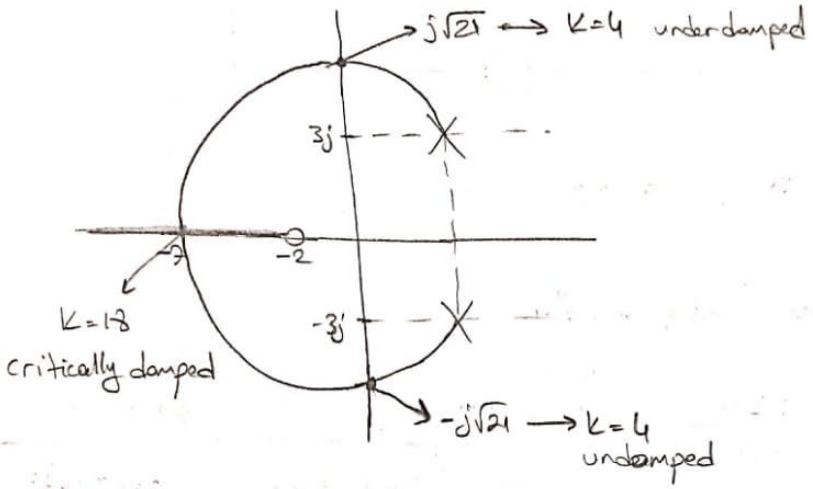


$$\theta_1 - \theta_2 - \theta_3 = \pm 180(2k+1)$$

$$\theta_3 = 180 - \theta_2 + \theta_1$$

$$\theta_3 = 180 - 90 + \tan^{-1}\left(\frac{3}{4}\right)$$

$$\theta_3 = 127°$$



$$Q(s) = s^2 + (k-4)s + 2k + 13 \xrightarrow{s=-7} 49 + (k-4)(-7) + 2k + 13 = 0$$

$$49 + 28 - 7k + 2k + 13 = 0$$

$$\boxed{k = 18}$$

→ Sistemi kararlı yapan K aralığı

$$Q(s) = s^2 + (k-4)s + 2k + 13$$

$$k - 4 > 0 \qquad k > 4$$

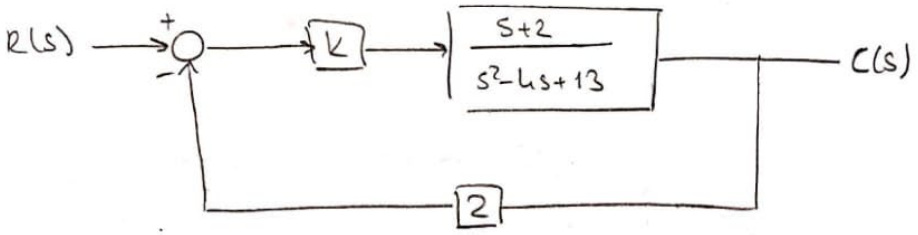
$$2k + 13 > 0 \qquad k > -\frac{13}{2}$$

s^2	1	$2K+13$
s^1	$(K-4)$	
s^0	$(2K+13)$	

$K-4>0 \longrightarrow K>4$

$2K+13>0 \longrightarrow K>-\frac{13}{2}$

$$\boxed{4<K<\infty}$$



$P_{1,2} = 2 \pm j3 \quad , \quad z = -2$

→ Sanal ekseni kestiği noktalar

$$G_{CL} = \frac{KGH}{1+KGH} = \frac{K(s+2)\,2}{s^2-4s+13+2Ks+4K} = \frac{2K(s+2)}{s^2+(2K-4)s+4K+13}$$

$Q(s) = s^2 + (2K-4)s + 4K + 13 \longrightarrow K = 2$

$Q(s) = s^2 + 21 \longrightarrow s_{1,2} = \pm j\sqrt{21}$

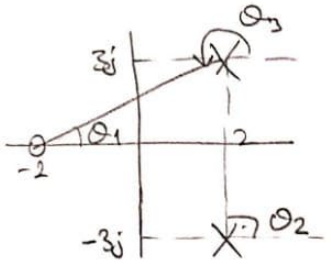
→ Reel eksenle birleşme noktaları

$$G_{CL} = \frac{KGH}{1+KGH} \quad , \quad 1+KGH = 0 \quad , \quad K = -\frac{1}{GH}$$

$$K = -\frac{(s^2+4s+13)}{2s+4} \quad , \quad \frac{dK}{ds} = -\frac{\left((2s-4)(2s+4) - (s^2-4s+13).2\right)}{(2s+4)^2} = 0$$

$$\frac{dK}{ds} = -\frac{(2s^2+8s-42)}{(2s+4)^2} = 0 \qquad s=3,\ \boxed{s=-7}$$

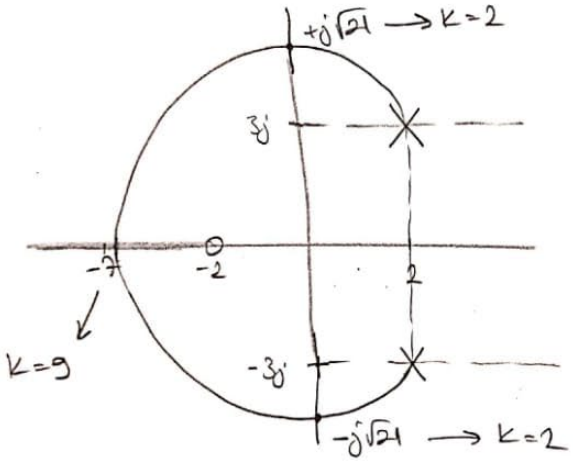
→ Komplex köklerin gidiş açıları



$$\theta_1 - \theta_2 - \theta_3 = \pm 180(2K+1)$$

$$\theta_3 = 180 - 90 + \tan^{-1}\left(\frac{3}{4}\right)$$

$$\boxed{\theta_3 = 127^\circ}$$



$$Q(s) = s^2 + (2K-4)s + 4K+13 \xrightarrow{s=-7} 49 + (2K-4)(-7) + 4K + 13 = 0$$

$$90 = 10K$$

$$\boxed{K=9}$$

→ Sistemi kararlı yapan K aralığı

$2K-4>0 \quad K>2$

$4K+13>0 \quad K>-\frac{13}{4}$

s^2	1	$4K+13$
s^1	$2K-4$	
s^0	$4K+13$	

$$\boxed{2 < K < \infty}$$

MATLAB KODU

```
clc;clear;close all;

%EX1
num=2*[1 2];
den=[1 -4 13];
G=tf(num,den);
rlocus(G)

%EX2
num=1;
den=[1 1];
den=conv([1 1],[1 2]);
den=conv(conv([1 1], [1 2]),[1 4]);
G=tf(num,den);
rlocus(G)

%EX3
num=1;
num=[1 5];
num=conv([1 5],[1 2]);
num=conv(conv([1 5],[1 2]),[1 0.5]);
den=conv(conv([1 0],[1 1]),[1 4]);
G=tf(num,den);
rlocus(G)
```

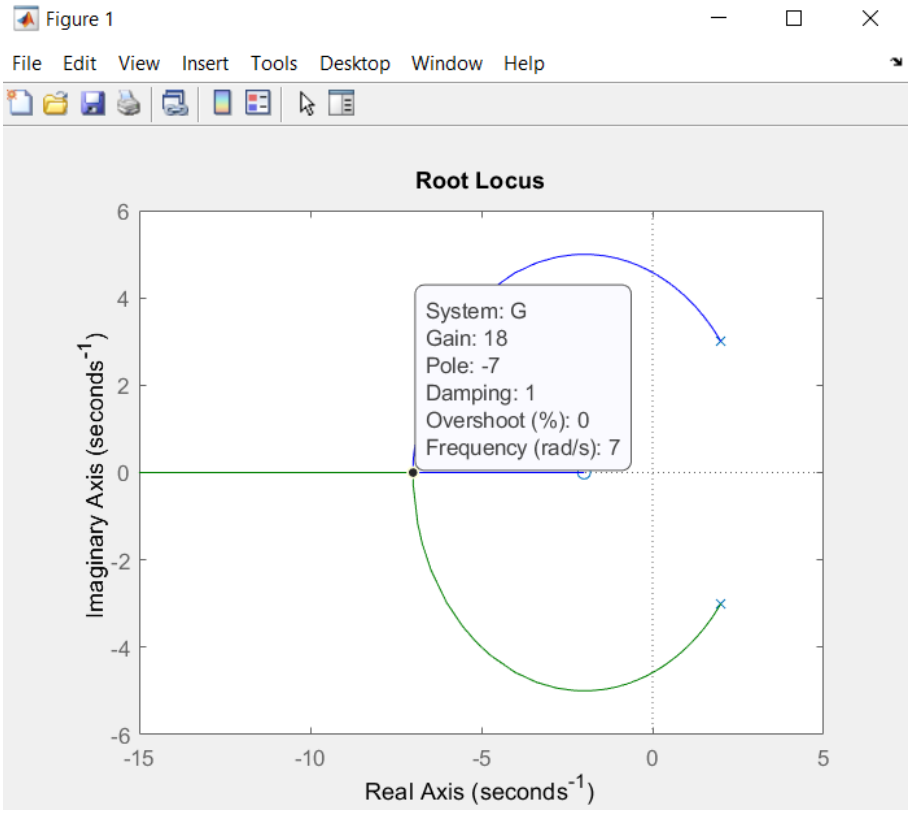


Figure 1 num=[1 2], den=[1 -4 13] için Root Locus

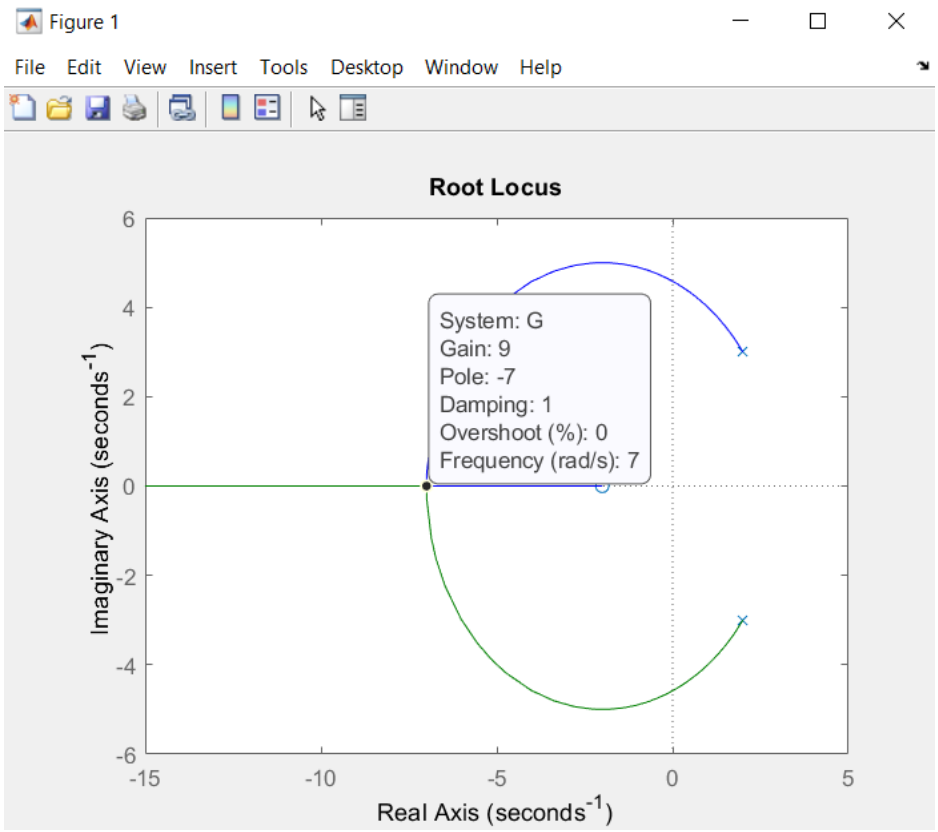


Figure 2 num=2[1 2], den=[1 -4 13] için Root Locus*

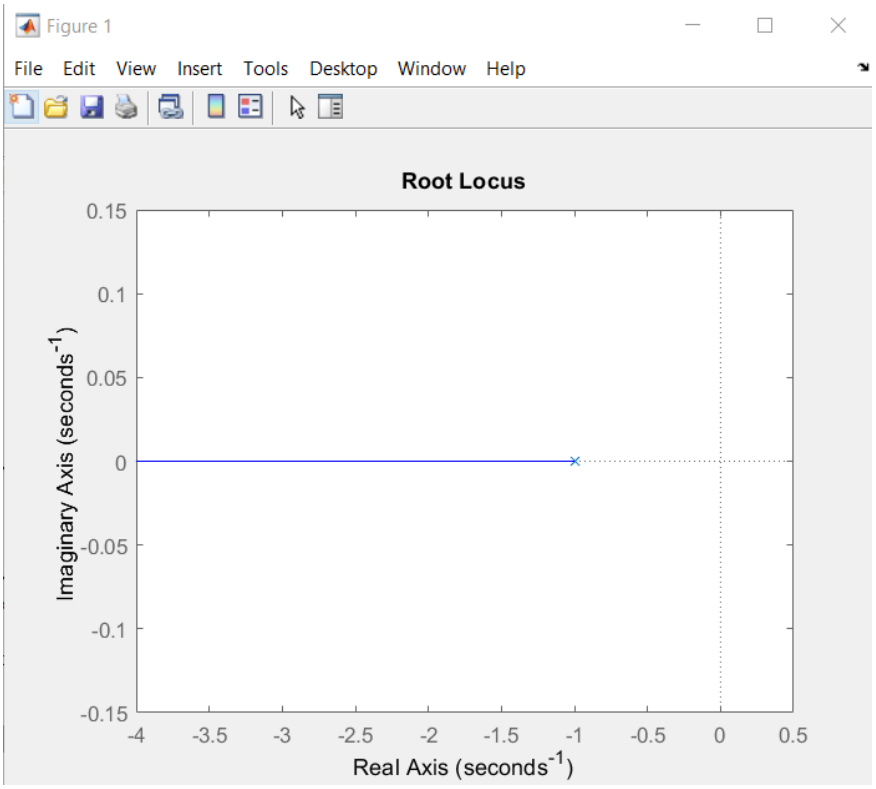


Figure 3 num=1, den=[1 1] için Root Locus

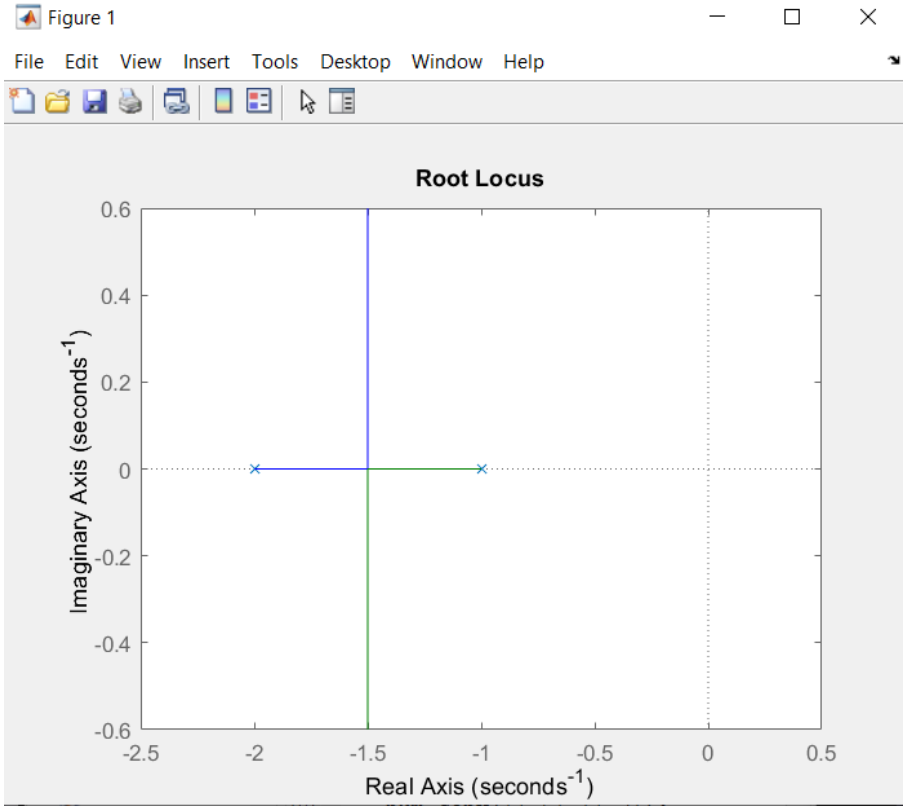


Figure 4 num=1, den=conv([1 1],[1 2]) için Root Locus

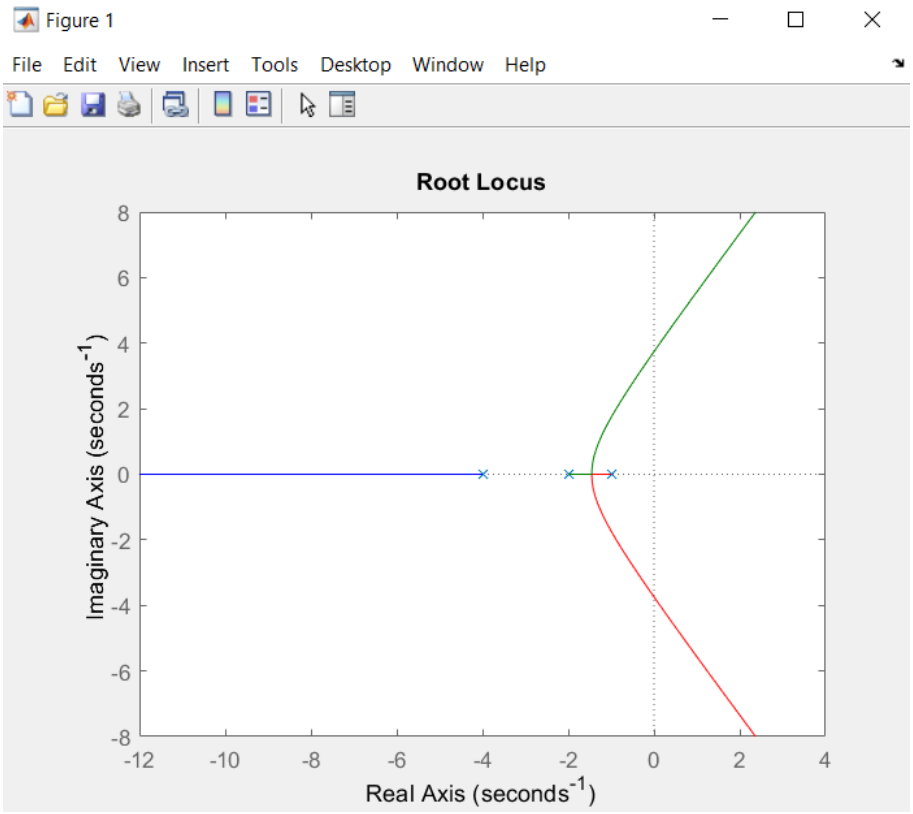


Figure 5 num=1, den=conv(conv([1 1], [1 2]),[1 4]) için Root Locus

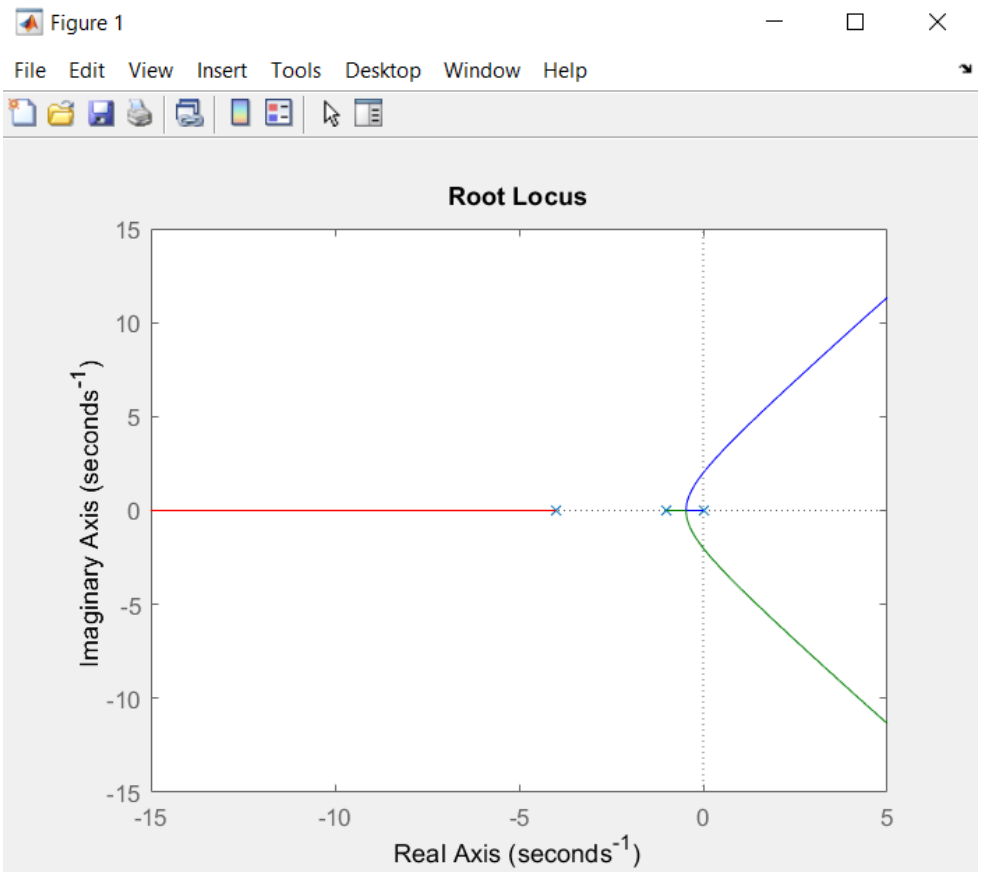


Figure 6 num=1, den=conv(conv([1 0],[1 1]),[1 4]) için Root Locus

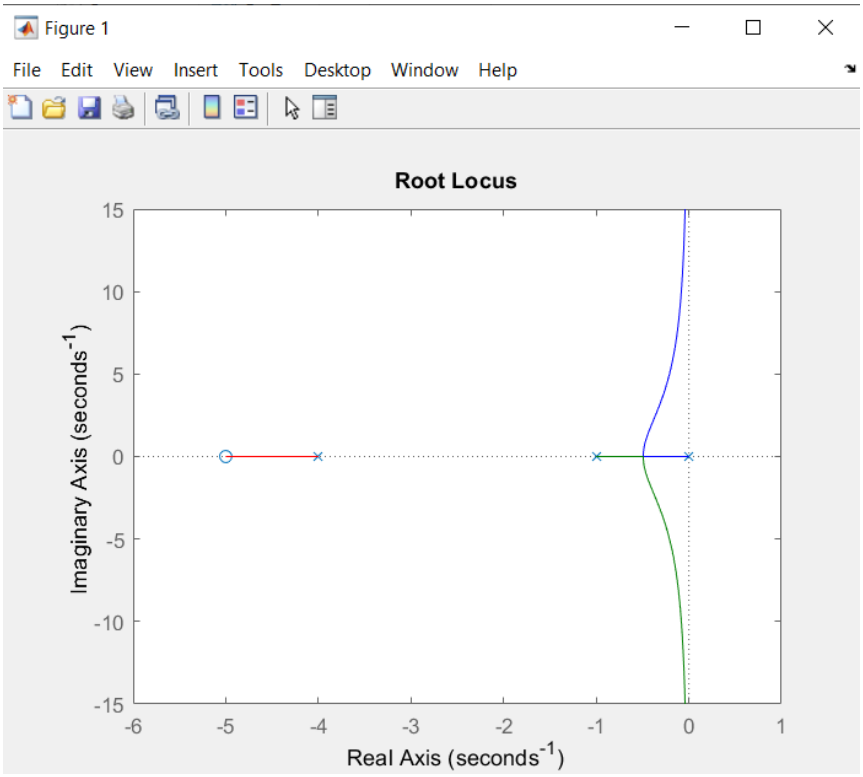


Figure 7 num=[1 5], den=conv(conv([1 0],[1 1]),[1 4]) için Root Locus

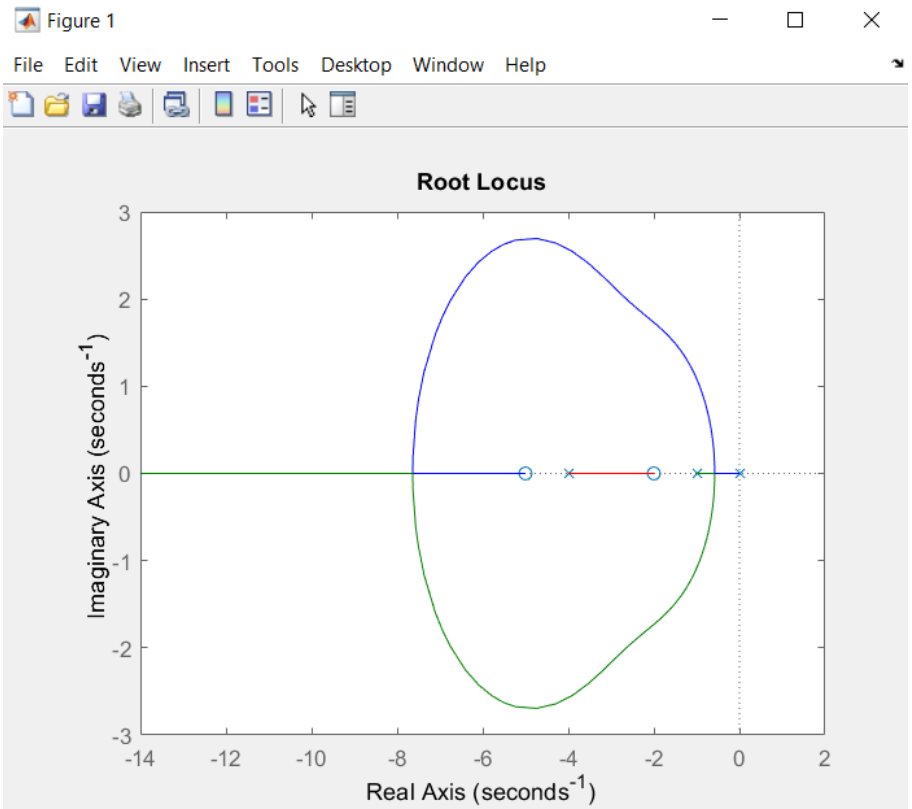


Figure 8 num=conv([1 5],[1 2]), den=conv(conv([1 0],[1 1]),[1 4]) için Root Locus

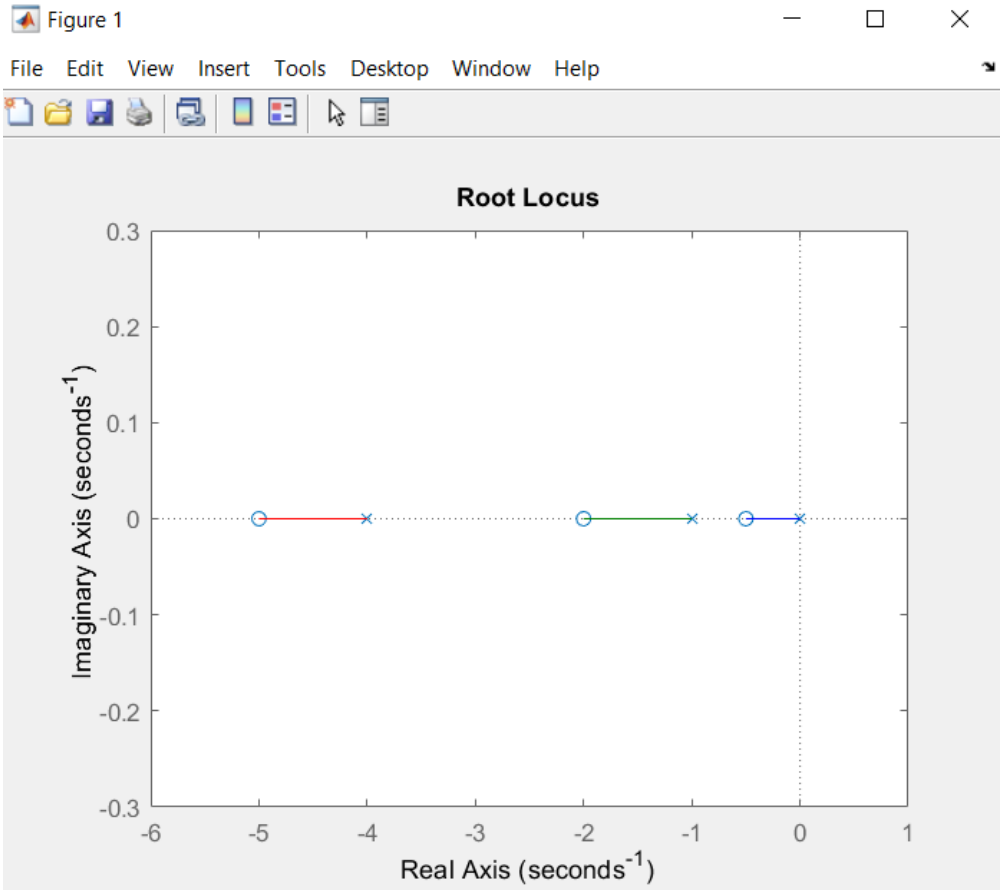


Figure 9 num=conv(conv([1 5],[1 2]),[1 0.5]), den=conv(conv([1 0],[1 1]),[1 4]) için Root Locus