T.C.

ONDOKUZ MAYIS ÜNİVERSİTESİ

MÜHENDİSLİK FAKÜLTESİ

BİLGİSAYAR MÜHENDİSLİĞİ BÖLÜMÜ

SAYISAL DENETİM-1

Dönem Sonu Projesi

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Sayısal Denetim I Dersi Dönem Sonu Projesi

$$G(s)H(s) = \frac{k(s+z)}{s(s+p_1)(s+p_2)(s+p_3)}$$

$z = 12$, $p_1 = 3$, $p_2 = 6$, $p_3 = 9$

$$G(s)H(s) = \frac{k(s+12)}{s(s+3)(s+6)(s+9)}$$

Sistemin kutupları = $[-3, -6, -9, 0]$ kutup sayısı = $n = 4$

Sistemin sıfırları = $[-12]$ sıfır sayısı = $m = 1$

Asimptot sayısı $= n - m = 4 - 1 = 3$

Asimptot açıları $(\beta) = \frac{(2k+1)}{n-m} = \mp 60°$

Asimptotun reel ekseni kestiği nokta

$$\frac{R\Sigma p_3 - R\Sigma_z z_3}{\text{Asimptot Sayısı}} = \frac{(-3-6-9)-(-12)}{3} = -2$$

Gerçek Eksenden Ayrılma Noktası

$$\left[\frac{1}{G(s)H(s)}\right] = 0 \;,\; \left[\frac{(s+3)(s+6)(s+9)}{(s+12)}\right] = 0$$

$$\frac{d}{ds}\left(\frac{s(s+3)(s+6)(s+9)}{s+12}\right)$$

$$= \frac{\frac{d}{ds}\left((s(s+3)(s+6)(s+9))(s+12) - \frac{d}{ds}(s+12)\,s(s+3)(s+6)(s+9)\right)}{(s+12)^2}$$

$$= \frac{d}{ds}\left(s(s+3)(s+6)(s+9)\right) = 4s^3 + 54s^2 + 198s + 162$$

$$= \frac{d}{ds}(s+12) = 1$$

$$= \frac{(4s^3+54s^2+198s+162)(s+12) - 1(s)(s+3)(s+6)(s+9)}{(s+12)^2}$$

$$= \frac{(4s^4+102s^3+846s^2+2538s+1944) - (s^4+18s^3+99s^2+162s)}{(s+12)^2}$$

$$= \frac{3s^4+84s^3+747s^2+2376s+1944}{(s+12)^2} = 0$$

Denklemin kökleri

$s_1 = -1.2290$

$s_2 = -4.7772 \rightarrow$ Ayrılma Noktası

$s_3 = -14.2479$

$s_4 = -7.7457$

Karakteristik Denklem $= 1 + G(s)H(s) = 0$

$$= 1 + \frac{k(s+12)}{s(s+3)(s+6)(s+9)}$$

$$= 1.s(s+3)(s+6)(s+9) + k(s+12) = 0$$

$$= (s^4+18s^3+99s^2+162s+ks+12k)$$

$$= s^4+18s^3+99s^2+(162+k)s+12k = 0$$

Routh Tablosu

$s^4 + 18s^3 + 99s^2 + (162+k)s + 12k = 0$

s^4	1	99	$12k$
s^3	18	$162+k$	0
s^2	b_1	$b_2 = 12k$	0
s^1	c_1	0	0
s^0	$d_1 = 12k$	0	0

$$b_1 = -\frac{\begin{vmatrix} 1 & 99 \\ 18 & 162+k \end{vmatrix}}{18} = 90-k$$

$$b_2 = \frac{\begin{vmatrix} 1 & 12k \\ 18 & 0 \end{vmatrix}}{18} = 12k$$

$$c_1 = \frac{\begin{vmatrix} 18 & (162+k) \\ b_1 & b_2 = 12k \end{vmatrix}}{b_1}$$

$$d_1 = \frac{\begin{vmatrix} b_1 & b_2 = 12k \\ c_1 & 0 \end{vmatrix}}{c_1} = 12k$$

$$c_1 = -\frac{k^2+144k-1458}{90-k}$$

b) $k^2+144k-1458 = 0$, $12k = 0$ $\Rightarrow k_3 = 0$

$k_1 = 68,5844$ $\quad k_2 = -212,5844$

$\hookrightarrow$ kritik kararlı

Sistemin kararlı olması için $0 < k < 68.5844$

s^4	1	99
s^3	18	$162+k$
s^2	$90-k$	$12k$
s^1	$-\frac{k^2+144k-1458}{90-k}$	0
s^0	$12k$	0

k değerini karakteristik denklemde yerine koyuyoruz.

Denklemin sanal kökleri

$$b_1 s^2 + 12k = (90-k)s^2 + 12k$$

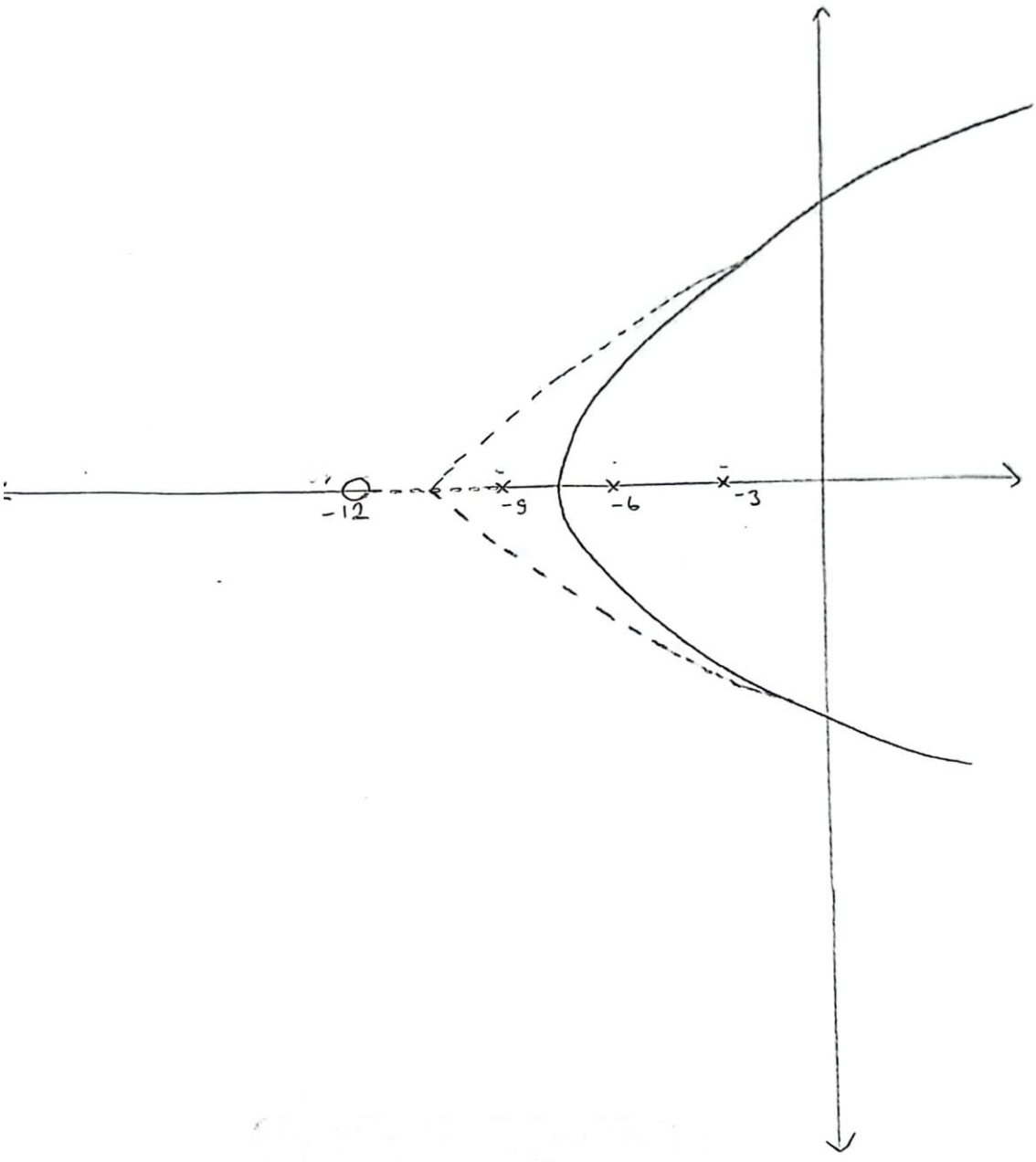
$$= (90 - 68.5844)s^2 + 12(68.5844)$$

$$= 21.4156\, s^2 + 823.0128$$

$$\Rightarrow S_1 = 6.19$$

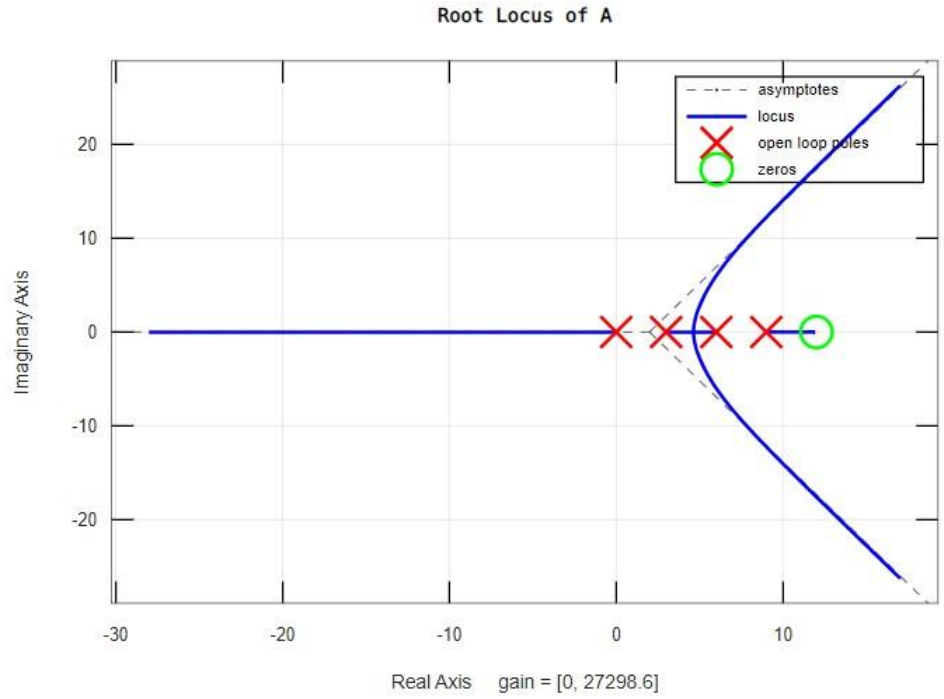
$$S_2 = -6.19$$

KÖK - YER EĞRİSİ



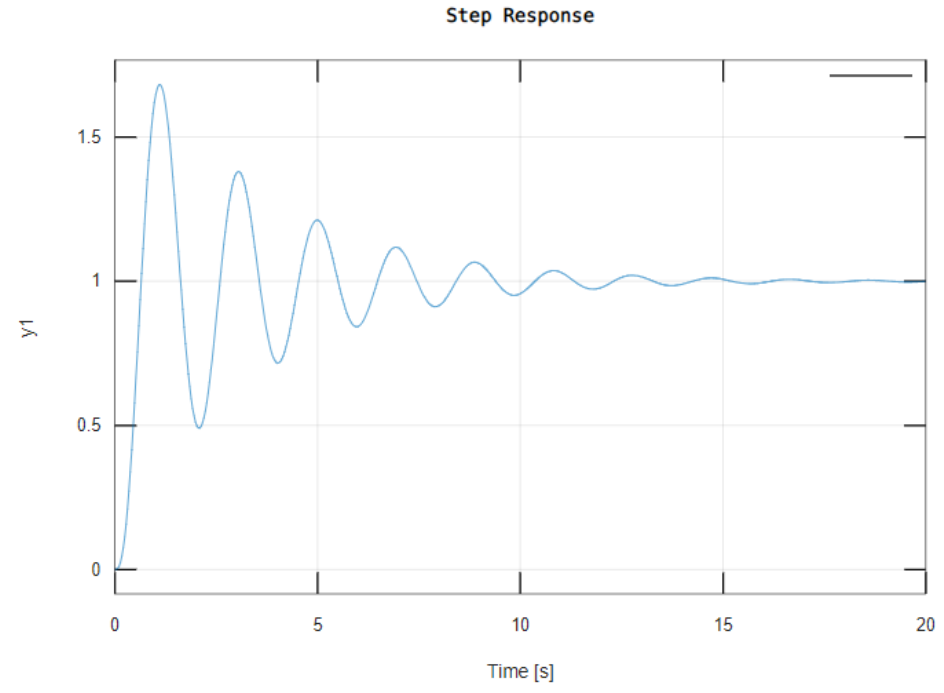
KÖK-YER EĞRİSİ

```
Continuous-time model.
octave:8> rlocus(A)
```



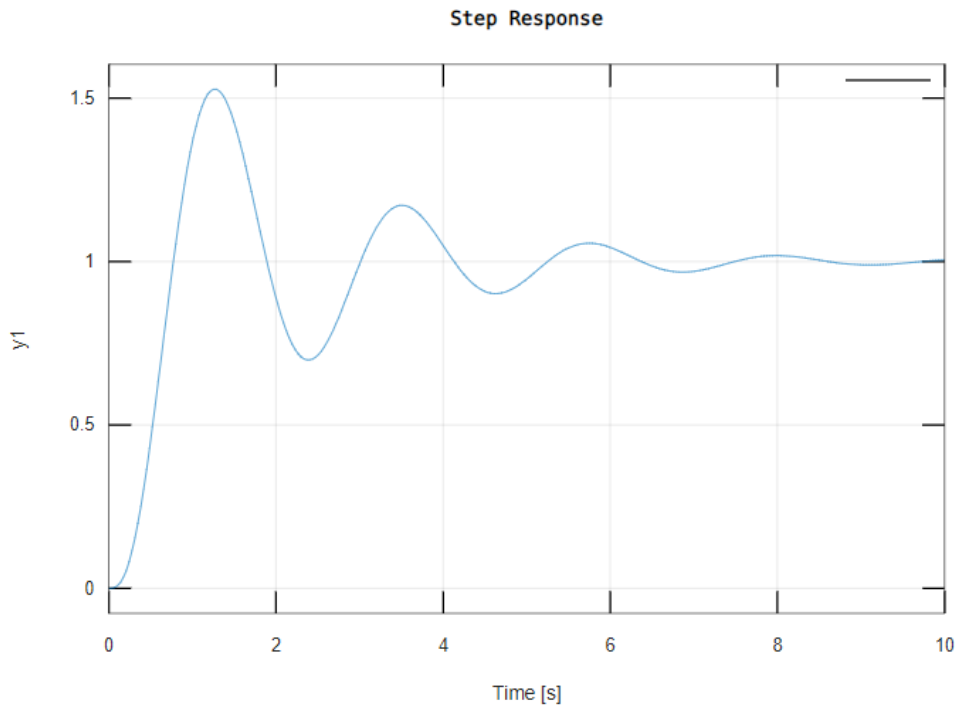
KRİTİK KARARLI DURUM

```
octave:4> K= 68.5844
K = 68.584
octave:5> step(K* A/(1+ K*A))
```



KARARLI DURUM

```
octave:8> K=50
K = 50
octave:9> step(K* A/(1+ K*A))
```



KARARSIZ DURUM

```
octave:12> K=212
K = 212
octave:13> step(K* A/(1+ K*A))
```