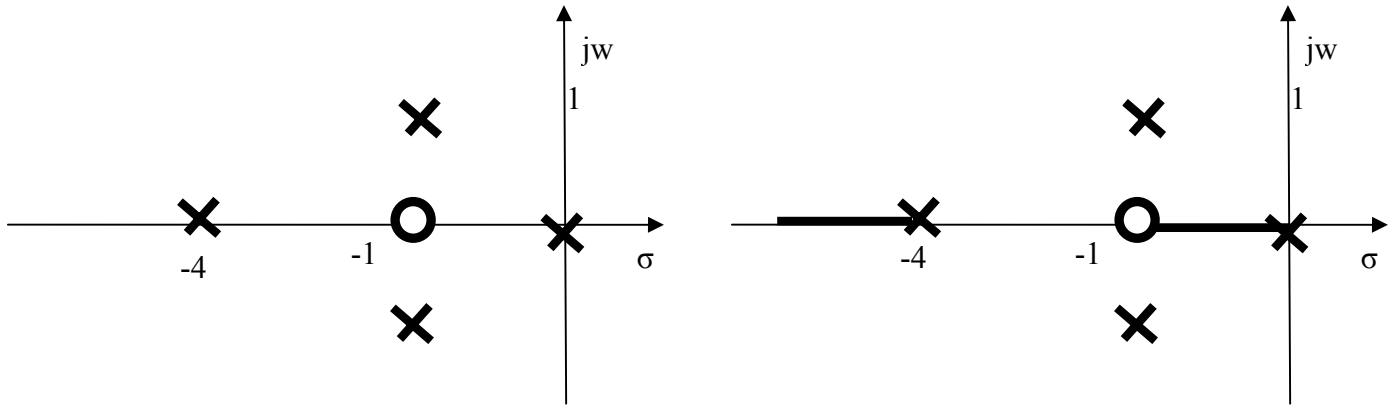


Örnek 8-5

$$G(s)H(s) = \frac{K(s+1)}{s(s+4)(s^2+2s+2)} \quad (8-37)$$

transfer fonksiyonunu ve buna karşı düşen

$$s(s+4)(s^2+2s+2) + K(s+1) = 0 \quad (8-38)$$



1. $K = 0$: Kök eğrisinde $K = 0$ noktaları $G(s)H(s)$ 'in $s = 0, -4, -1 + j$ ve $-1 - j$ kutuplarına karşı düşer.
2. $K = \pm \infty$: Kök eğrisinde $K = \pm \infty$ noktaları $G(s)H(s)$ 'in $s = -1, \infty, \infty$ ve ∞ sıfırlarına karşı düşer.
3. Kol sayısı: (8-37) ve (8-38) denklemleri dördüncü mertebeden olduğu için kök eğrisi dört kolludur.
4. Simetri: Kök eğrisi gerçekte eksene göre simetriktir.

ASİMTOTLAR

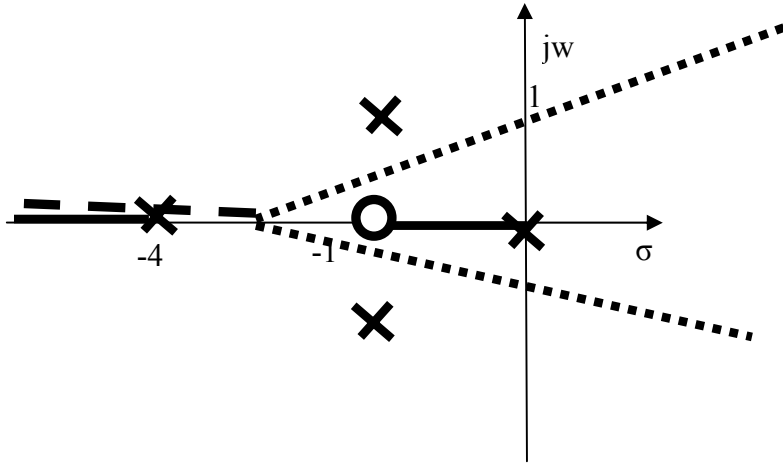
$$\sigma_A = \frac{\sum(-p_j) - \sum(-z_l)}{n_p - n_z}$$

$$\phi_A = \frac{(2q+1)}{n_p - n_z} 180^\circ, q = 0, 1, 2, \dots$$

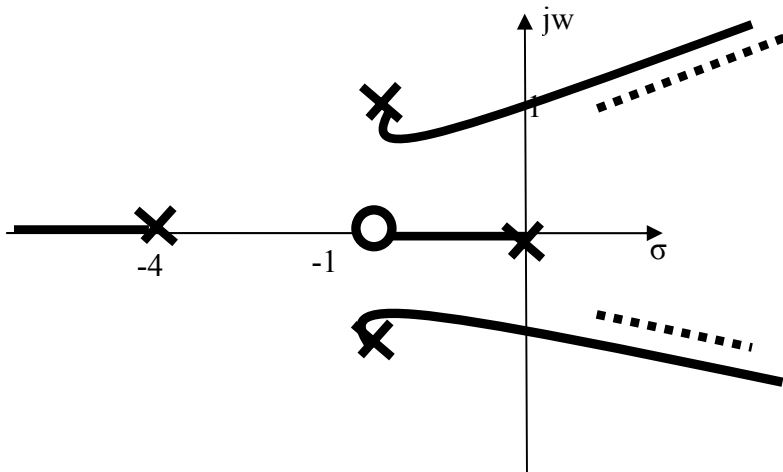
$$i = 0: \theta_0 = \frac{180^\circ}{3} = 60^\circ$$

$$i = 1: \theta_1 = \frac{540^\circ}{3} = 180^\circ$$

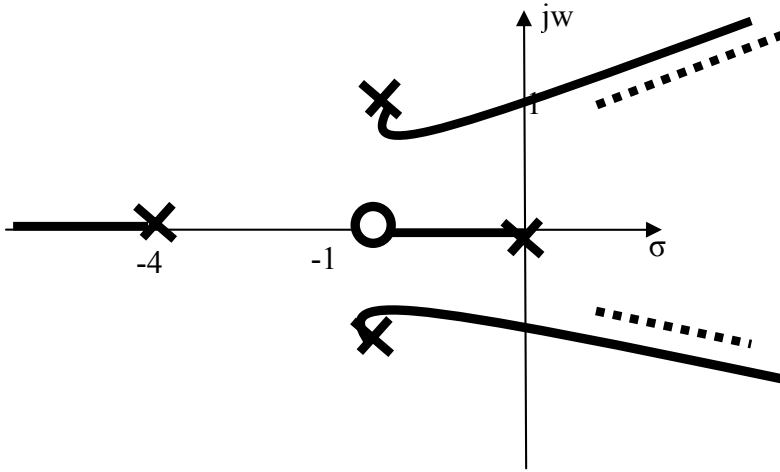
$$\sigma_1 = \frac{(-4 - 1 - 1) - (-1)}{4 - 1} = -\frac{5}{3} \quad i = 2: \theta_2 = \frac{900^\circ}{3} = 300^\circ$$



Bu bilgiler isiginda tahmini çizim



jw eksenini kestigi nokta Routh Hurwitz kriterinden bulunur.



$$s(s+4)(s^2+2s+2)+K(s+1)=s^4+6s^3+10s^2+8s+Ks+K=s^4+6s^3+10s^2+(8+K)s+K=$$

$$K=-16.7846, \text{ roots}([1 \ 6 \ 10 \ 8+K \ K])$$

$$\begin{array}{c|ccc} s^n & a_n & a_{n-2} & a_{n-4} \\ s^{n-1} & a_{n-1} & a_{n-3} & a_{n-5} \\ s^{n-2} & b_{n-1} & b_{n-3} & b_{n-5} \\ s^{n-3} & c_{n-1} & c_{n-3} & c_{n-5} \end{array}$$

$$b_{n-1} = \frac{-1}{a_{n-1}} \begin{vmatrix} a_n & a_{n-2} \\ a_{n-1} & a_{n-3} \end{vmatrix},$$

$$b_{n-3} = -\frac{1}{a_{n-1}} \begin{vmatrix} a_n & a_{n-4} \\ a_{n-1} & a_{n-5} \end{vmatrix}$$

$$c_{n-1} = \frac{-1}{b_{n-1}} \begin{vmatrix} a_{n-1} & a_{n-3} \\ b_{n-1} & b_{n-3} \end{vmatrix},$$

1	10	K	0		
6	8+K	0	0		
A1	A3	A5			
B1	B2				
C1					

$$A1=(-1/6) [(1)(8+K)-10 \times 6] = (-1/6) [8+K - 60] = -[K-52]/6 = [52-K]/6$$

$$A3=(-1/6) [(1)(0)-K \times 6] = K$$

$$A5=0$$

$$B1=(-1/A1)[6 A3 - (8+K)A1] = -6/(52-K) [6K - (8+K)(52-K)/6] = -6 \frac{6K - (8+K)(52-K)/6}{(52-K)} = -\frac{K^2 - 8K - 416}{(52-K)}$$

1	10	K	0		
6	8+K	0			
(52-K)/6	K	0			
$-\frac{K^2 - 8K - 416}{(52-K)}$	0	0			
K	0	0			
0					

$A1>0, B1>0, C1>0$ olmalıdır.

$A1>0,$	$(52-K)/6,$	$K<52$
$B1>0$	$-\frac{K^2 - 8K - 416}{(52-K)} > 0, K<52, \text{ ve } -(K^2 - 8K - 416)>0$ olmalıdır	$-16.7846<K<24.7846$

	$K < 52$ sarti yukaridan geldigi icin onu kullandik. $-(K^2 - 8K - 416) > 0 \implies (K^2 - 8K - 416) < 0,$	
$C1 > 0$	$K > 0$	$K > 0$

Sartlari inceledigimizde zorlayici sartlarin $0 < K < 24.7846$ oldugunu goruruz. Bu da bize K nin bu degerleri icin geometrik yerlerin jw eksenini kestigini soylar.

K						
-0.2000	-3.9849	-1.0200-0.9901i	-1.0200+0.9901i	0.0248		
-0.1000	-3.9925	-1.0100-0.9950i	-1.0100+0.9950i	0.0125		
-0.0100	-3.9992	-1.0010-0.9995i	-1.0010+0.9995i	0.0012		
0	0	-4.0000	-1.0000-1.0000i	-1.0000+1.0000i		
0.0100	-4.0007	-0.9990-1.0005i	-0.9990+1.0005i	-0.0013		
0.1000	-4.0075	-0.9900-1.0050i	-0.9900+1.0050i	-0.0125		
0.2000	-4.0149	-0.9800-1.0101i	-0.9800+1.0101i	-0.0252		

24.0000	-5.0885	-0.0139-2.3102i	-0.0139+2.3102i	-0.8837		
24.7000	-5.1102	-0.0015-2.3346i	-0.0015+2.3346i	-0.8868		
24.7800	-5.1127	-0.0001-2.3374i	-0.0001+2.3374i	-0.8871		
24.7846	-5.1128	-0.0000-2.3375i	-0.0000+2.3375i	-0.8872		
24.7900	-5.1130	0.0001-2.3377i	0.0001+2.3377i	-0.8872		
24.8000	-5.1133	0.0003-2.3381i	0.0003+2.3381i	-0.8872		
25.0000	-5.1195	0.0038-2.3449i	0.0038+2.3449i	-0.8881		
26.0000	-5.1498	0.0210-2.3788i	0.0210+2.3788i	-0.8921		

$KK = [-0.2 \ -0.1 \ -0.01 \ 0 \ 0.01 \ 0.1 \ 0.2 \ 24. \ 24.7 \ 24.78 \ 24.7846 \ 24.79 \ 24.8 \ 25 \ 26]$

```
qq=[];
for kk=1:10
    qq(kk,:)= [KK(kk) [roots([1 6 10 8+K K]))' ]
end;
```