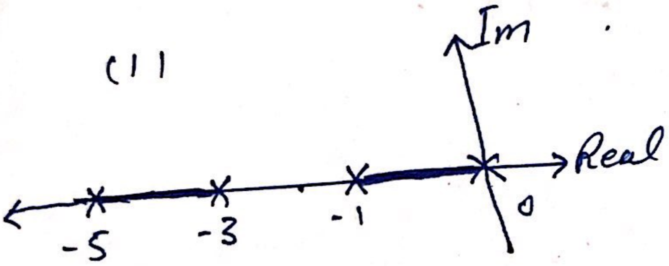
Example:→ $L(s) = \dfrac{1}{s(s+1)(s+3)(s+5)}$

$n = 4, \quad m = 0$

No. of branches $= 4 = n$

no. of assymptotes $= n - m = 4$ ∵ no zeros

(1)



(2) Centre & angle of assymptotes

$$\alpha = \frac{\Sigma P_i - \Sigma z_i}{n-m} = \frac{0-1-3-5}{4} = \frac{-9}{4} = -2.25$$

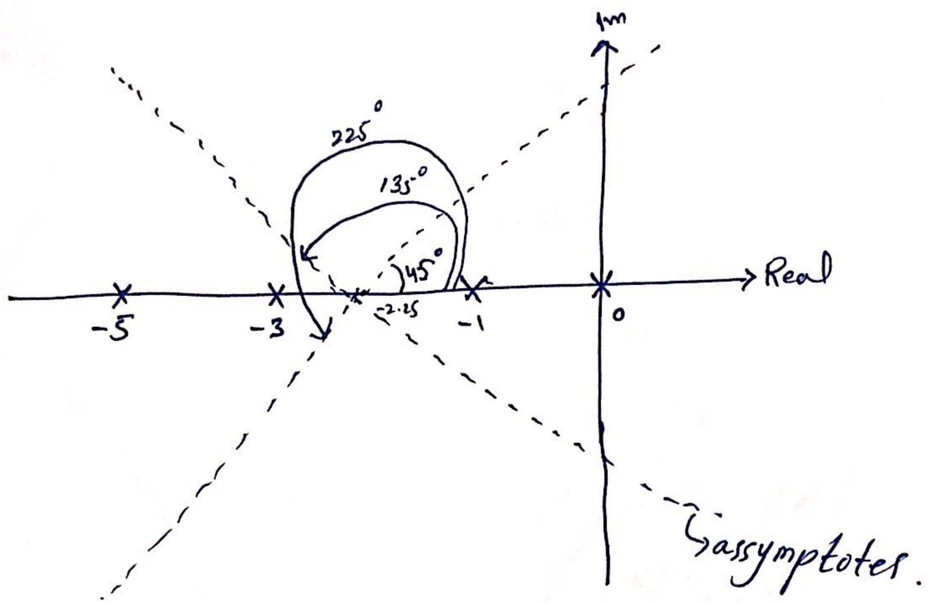
$$\phi_1 = \frac{180^\circ}{4} = 45^\circ, \quad \phi_2 = \frac{180^\circ + 360^\circ}{4} = \frac{540^\circ}{4}$$

$$\phi_2 = 135^\circ, \quad \phi_3 = \frac{180^\circ + 360^\circ(2)}{4} = \frac{180^\circ + 720^\circ}{4}$$

$$\phi_3 = \frac{900^\circ}{4} = 225^\circ, \quad \phi_4 = \frac{180^\circ + 360^\circ(3)}{4}$$

$$\phi_4 = \frac{180^\circ + 1080^\circ}{4} = \frac{1260^\circ}{4} = \boxed{315^\circ}$$

$$\boxed{\phi_1 = 45^\circ, \quad \phi_2 = 135^\circ, \quad \phi_3 = 225^\circ, \quad \phi_4 = 315^\circ}$$



3 Breakaway Point

$$L(s) = \frac{1}{s(s+1)(s+3)(s+5)} = \frac{1}{s(s^2+4s+3)(s+5)}$$

$$= \frac{1}{s\left[s^3+4s^2+3s+5s^2+20s+15\right]}$$

$$= \frac{1}{s\left[s^3+9s^2+23s+15\right]} = \frac{1}{s^4+9s^3+23s^2+15s}$$

$1 = a(s)$

$s^4+9s^3+23s^2+15s \to b(s)$

$$b(s)\underbrace{\frac{da(s)}{ds}}_{0} - a(s)\frac{db(s)}{ds} = 0$$

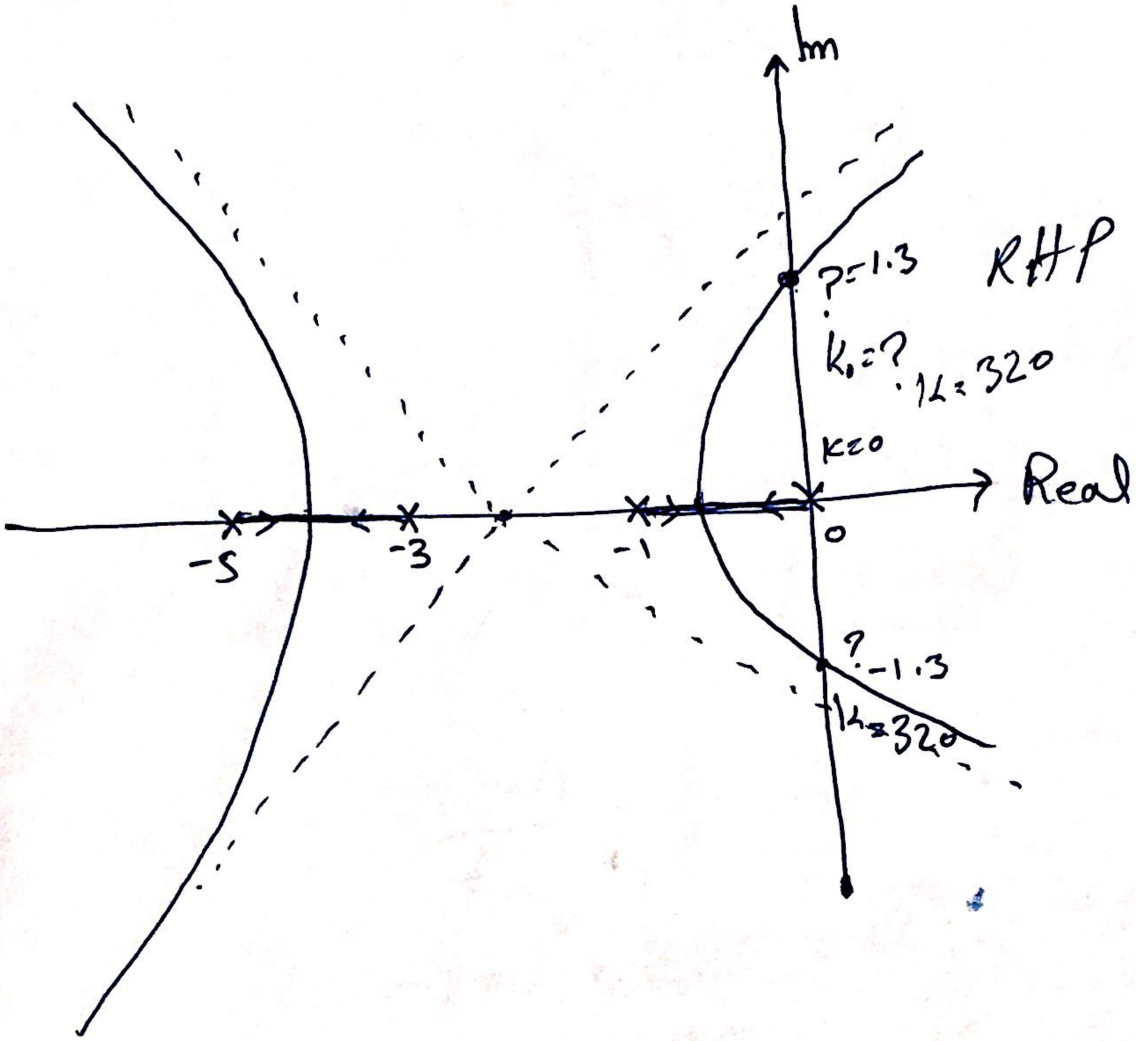
$$= -\frac{d}{ds}\left(s^4+9s^3+23s^2+15s\right) = 4s^3+27s^2 + 46s+15 = 0$$

$$4s^3+27s^2+46s+15 = 0$$

$S_1 \simeq -4.3 \rightarrow$ Valid

$S_2 \simeq -2 \rightarrow$ Invalid.

$S_3 \simeq -0.5 \rightarrow$ Valid



New Rule

④ Jw- Crossing

$$1 + G(s)K = 0 \quad 1 + \frac{K}{s(s+1)(s+3)(s+5)} = 0$$

$$= s^4 + 9s^3 + 23s^2 + 15s + K = 0$$

By Routh Hurwitz criterion.

s^4	1	23	K
s^3	9	15	0
s^2	$\frac{207-15}{9}$	$K/9$	
s^1	$\frac{K-320}{21.3}$		
s^0	$K/9$		

$$\frac{K-320}{21.3} = 0 \Rightarrow K-320=0$$

$$\boxed{K=320}$$

$$s^2: \quad \frac{207-15}{9} + \frac{K}{9} = 0$$

$$192s^2 + 320 = 0 \qquad \because K=320$$

$$s^2 = \frac{-320}{192} \approx -1.7$$

$$\boxed{s_{1,2} \approx \pm j1.3}$$