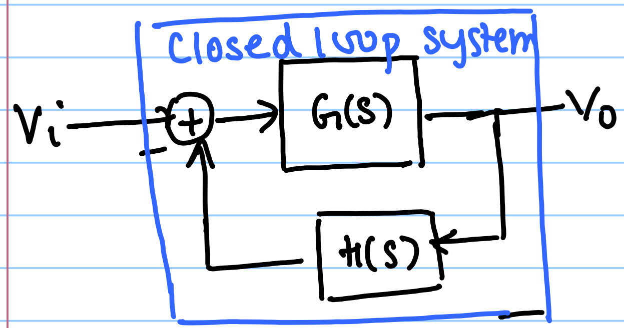
Note Title

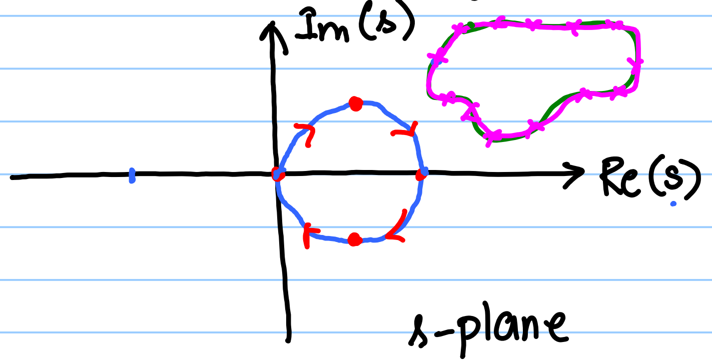
Lecture # 47

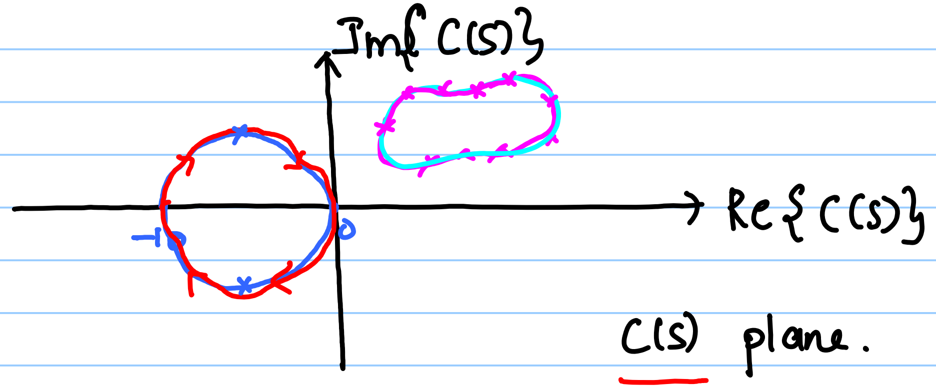


$H_{cl}(s) = \frac{V_o}{V_i} = \frac{G(s)}{1+G(s)H(s)}$

- Closed loop system is stable iff all poles are in left half plane ✓
- Even a single pole R.H.P will make system unstable
- Roots of $1+G(s)H(s) = 0 \Rightarrow$ poles
- $L\,G(s) = G(s)\,H(s)$

Nyquist Stability Criterian.





$C(s) = s - 10$ ✓

at $s = 0$: $C(s) = -10$

$s = 10$: $C(s) = 0$

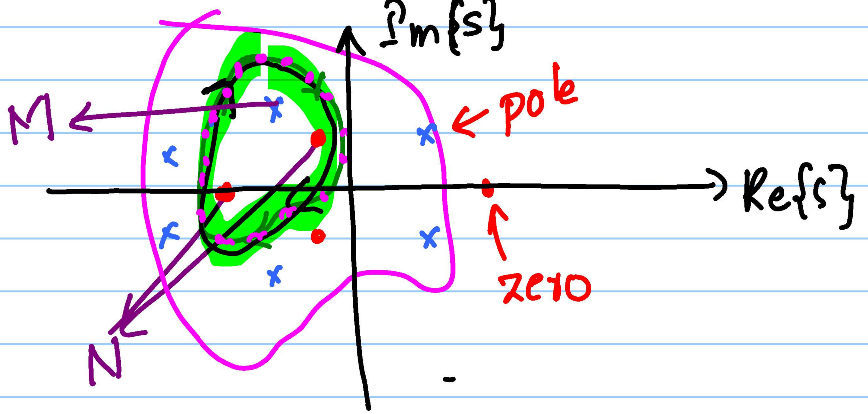
$s = 5+5j$: $C(s) = -5+5j$

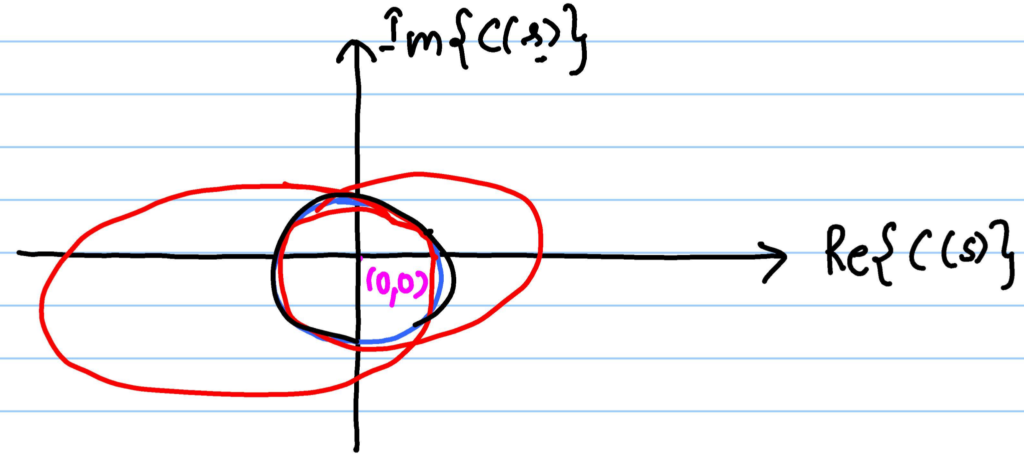
$s = 5-5j$: $C(s) = -5-5j$

- If I go through a closed path in s-plane and C(s) is define for each s. value of the path, then I will go through a closed path in C(s) plane.

$$C(s) = \frac{(s-z_1)(s-z_2)\cdots(s-z_k)}{(s-p_1)(s-p_2)\cdots(s-p_l)}$$

C(s) has k-zeroes and l-poles.

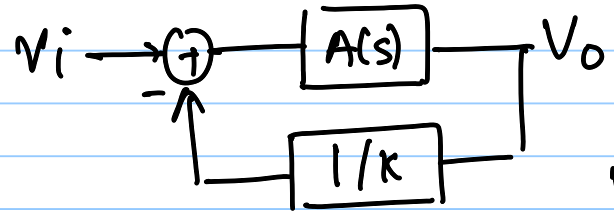




C(s) will also have a closed contour while encircling (0,0) N-M times if N zeros & M poles are inside the closed contour in s-plane.

It will encircle (0,0) in clockwise direction if N > M otherwise it will encircle in counter clockwise direction.

stability. $H_{cl}(s) = \frac{V_o}{V_i} = \frac{k}{1+\frac{k}{A(s)}}$.



$$\frac{V_o}{V_i} = \frac{A(s)}{1+\frac{A(s)}{K}}$$

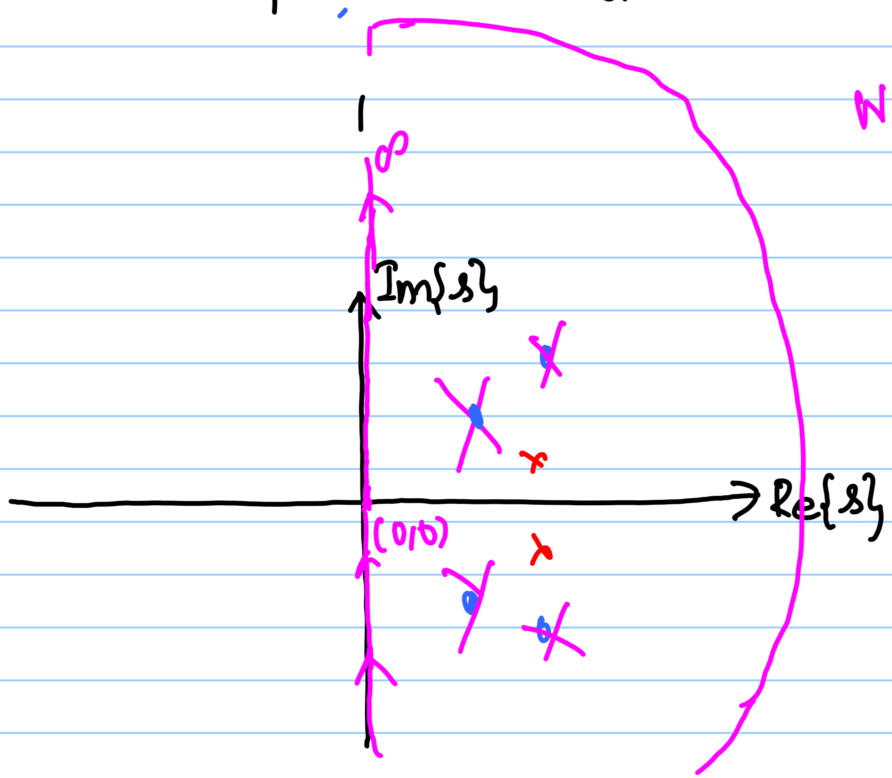
Poles of closed loop tf : Roots of $1+\frac{k}{A(s)} = 0$

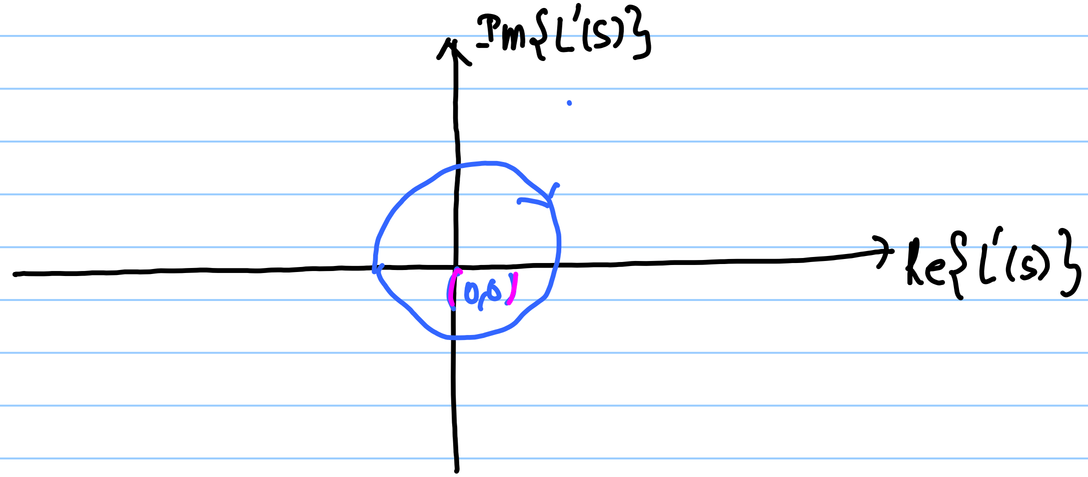
$$1+\frac{k D_2(s)}{N_2(s)} = \frac{N_2(s)+k D_2(s)}{N_2(s)} = 0$$

$\Rightarrow$ Zeroes of
$$\begin{cases} N_L(s) + k\,D_L(s) = 0 \\ \dfrac{N_L(s)}{D_L(s)} + k = 0 \Rightarrow \dfrac{1}{k}\,\dfrac{N_L(s)}{D_L(s)} + 1 = L'(s) = 0 \\ \dfrac{1}{k}\,\dfrac{N_L(s)}{D_L(s)} = -1 \end{cases}$$

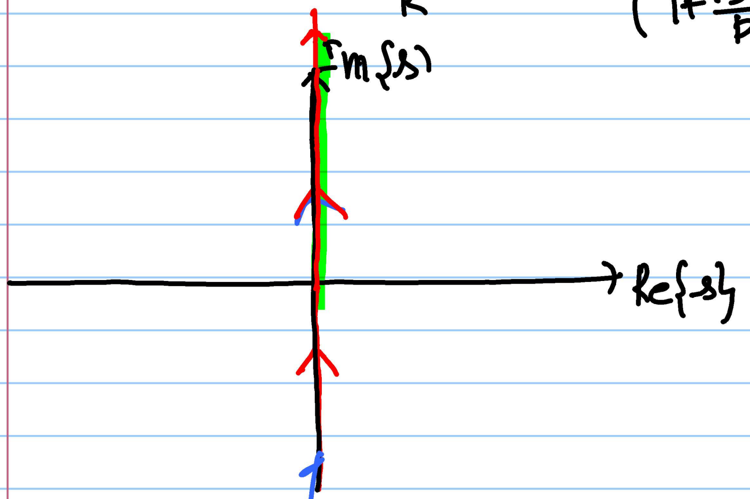
No R.H.P pole for $H_{cl}(s)$ = No R.H.P zero for $\dfrac{N_L(s) + k\,D_L(s) = 0}{N_e(s)}$

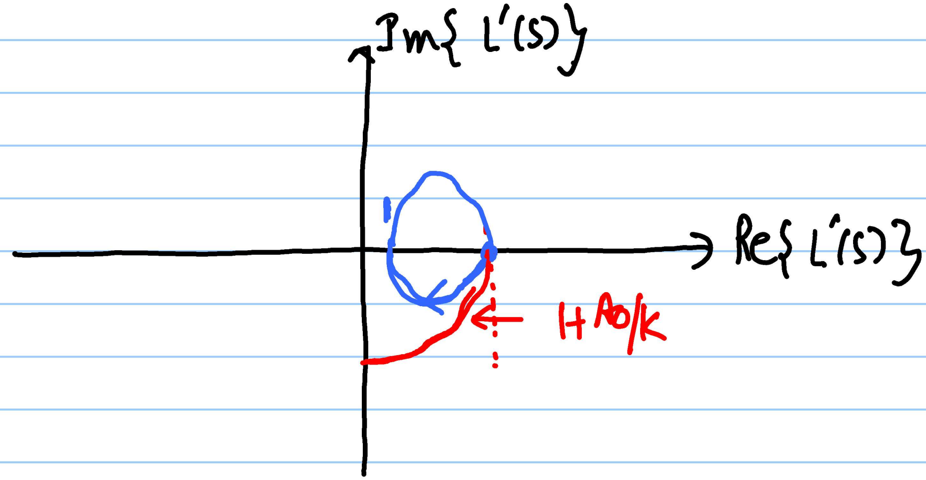
No roots in R.H.P for $L'(s) = 0$





$$L'(s) = 1 + \frac{A(s)}{K} = 1 + \frac{A_0}{\left(1+\frac{s}{p_1}\right)} \frac{1}{K}$$

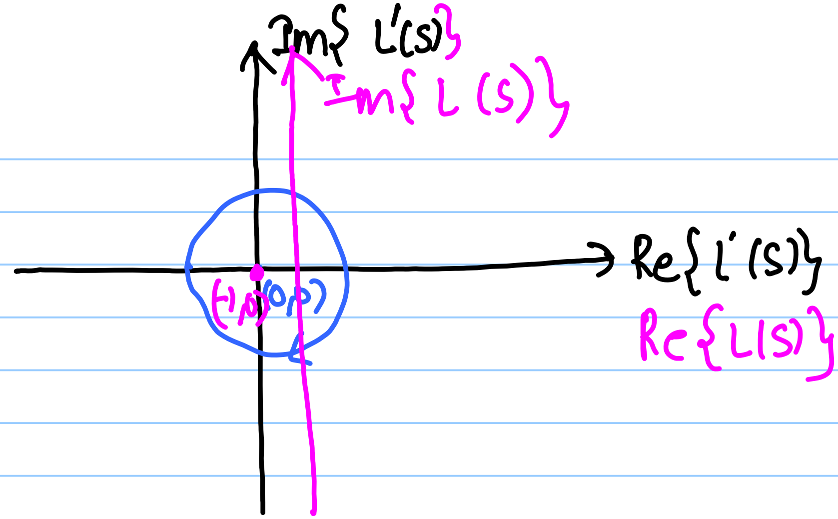




at $s = 0$, $L'(s) = 1 + \frac{A_0}{\left(1+\frac{0}{p_1}\right)} \frac{1}{K}$

$$= 1 + \frac{A_0}{\sqrt{1+\frac{\omega^2}{p_1^2}}} \frac{1}{K} e^{-j\omega/p_1}$$

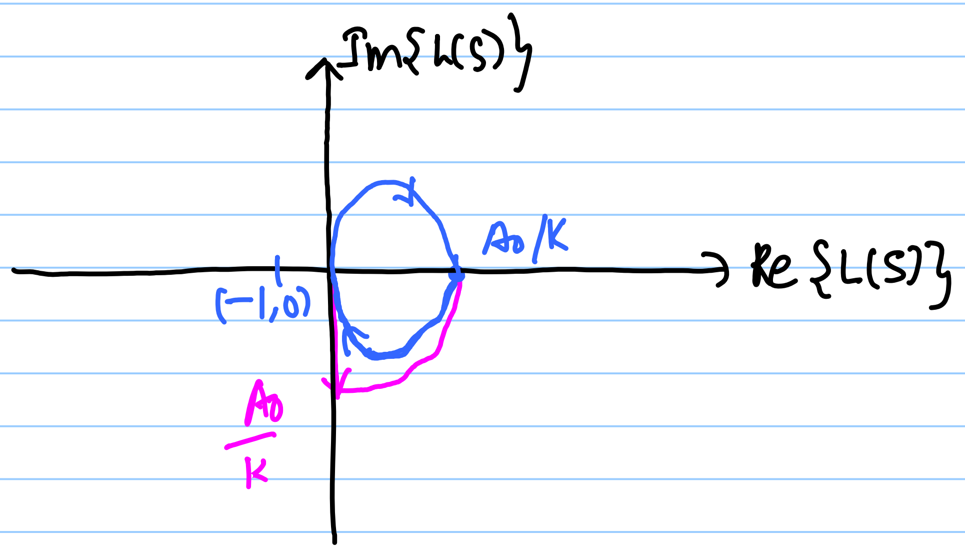
$$= \left\{1 + \frac{A_0/K}{\sqrt{1+\omega^2/p_1^2}} \cos(\omega/p_1)\right\} - j \frac{A_0/K}{\sqrt{1+\omega^2/p_1^2}} \sin(\omega/p_1)$$



$L'(s) = L(s) + 1$

- Plotting $L'(s)$ and finding encirclement of $(0,0)$ is same as plotting $L(s)$ and finding encirclement of $(-1,0)$

$L'(s) - 1 = L(s)$



$$L(s) = \frac{A_0/K}{\left(1+\frac{s}{p_1}\right)}$$

$$= \frac{A_0/K}{\sqrt{1+\frac{\omega^2}{p_1^2}}} e^{-j\omega/p_1}$$

at $\omega \to \infty$, $L(s) \to 0$