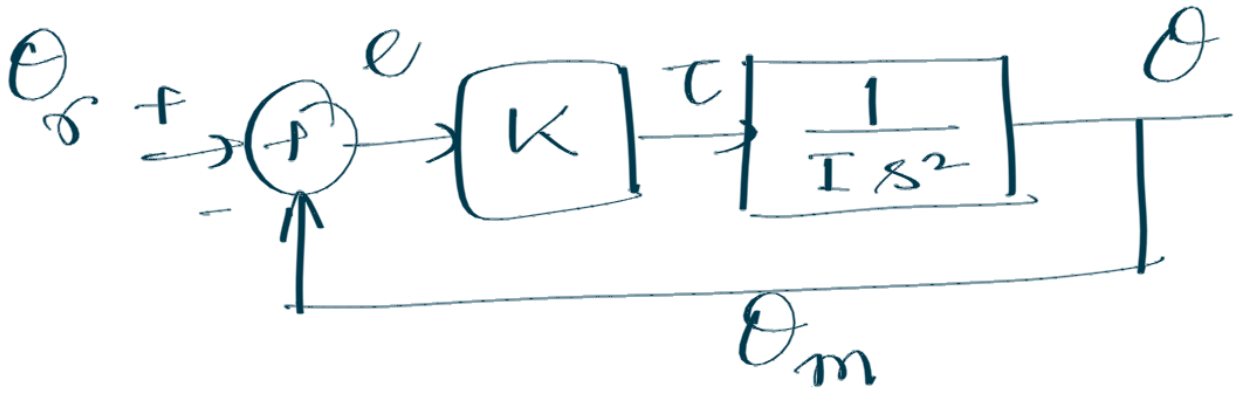
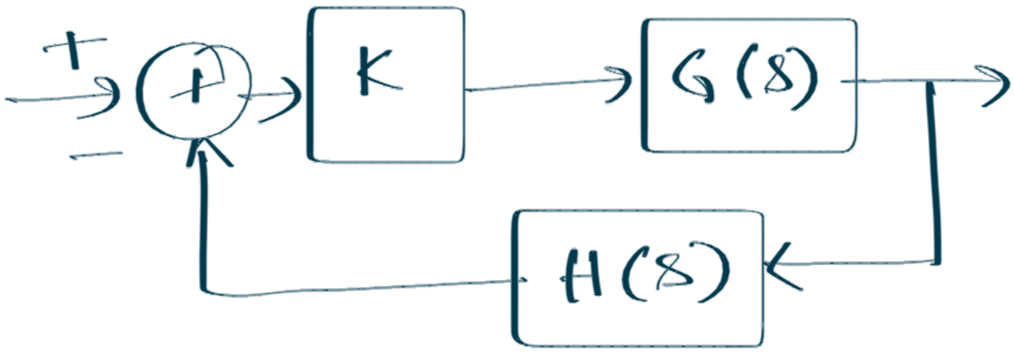
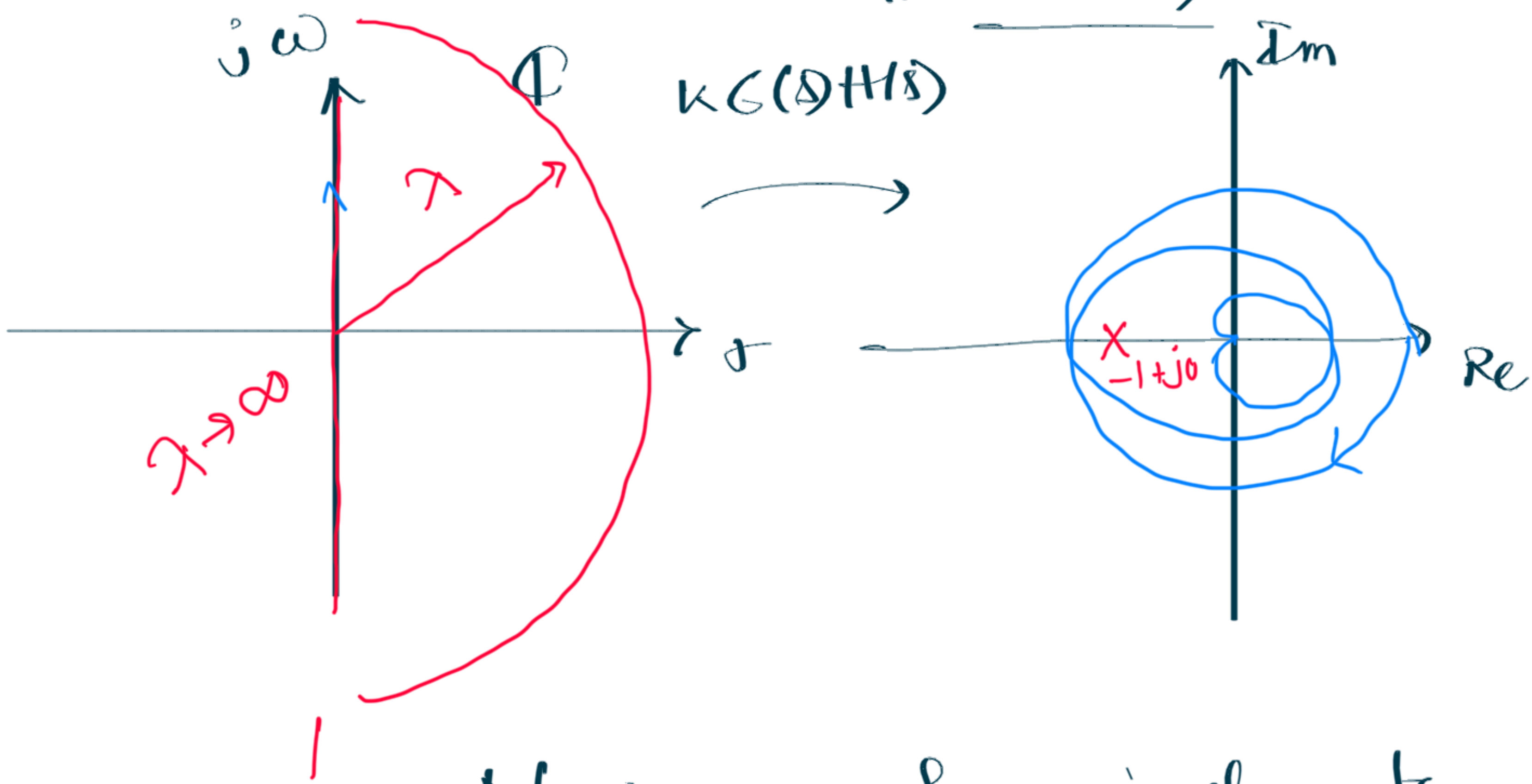
4th March:



Nyquist criteria:



$$KG(s)H(s) = \frac{K\prod(s-z_i)}{\prod(s-p_i)}$$



N → no. of encirclements of −1 + j0

$$\boxed{N = P - Z}$$

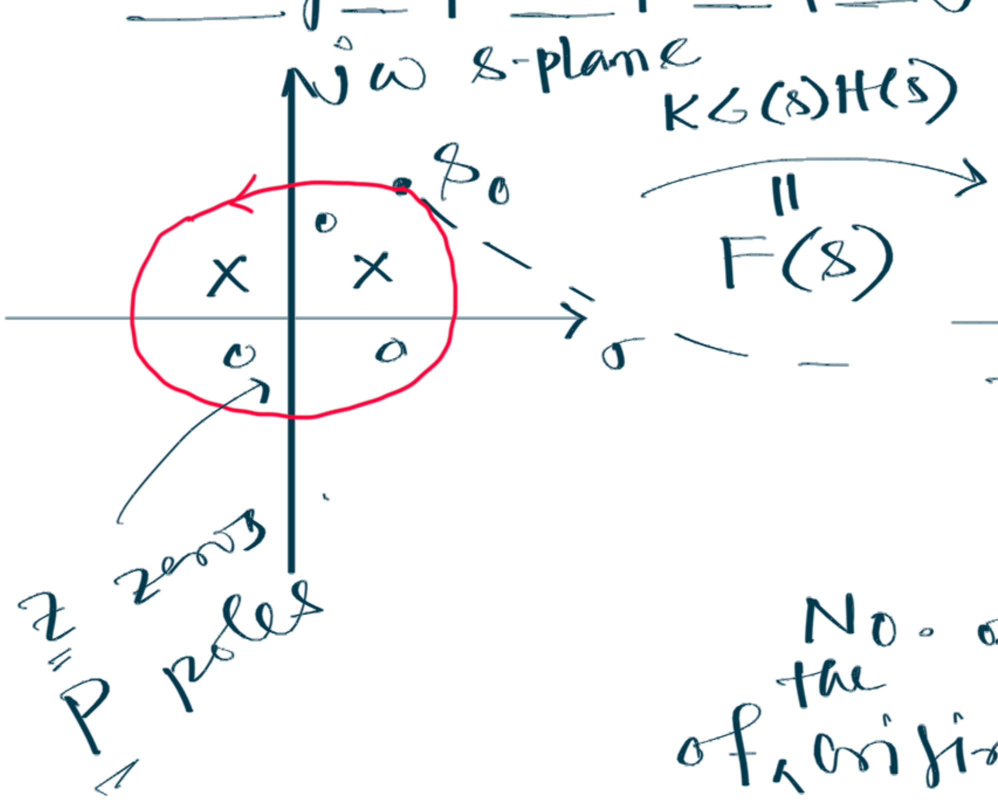
↑

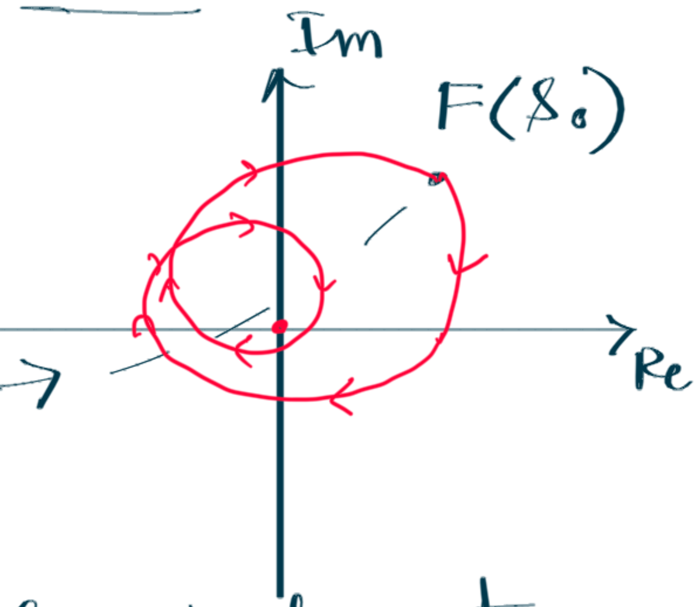
1 + KG(s) H(s)

Stability of the closed loop

⟺ Z = 0

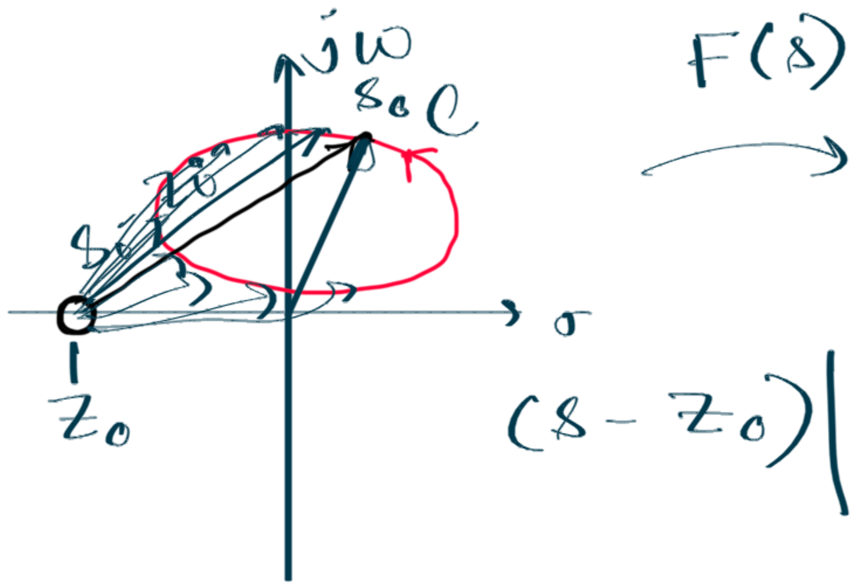
Cauchy's principle of argument:

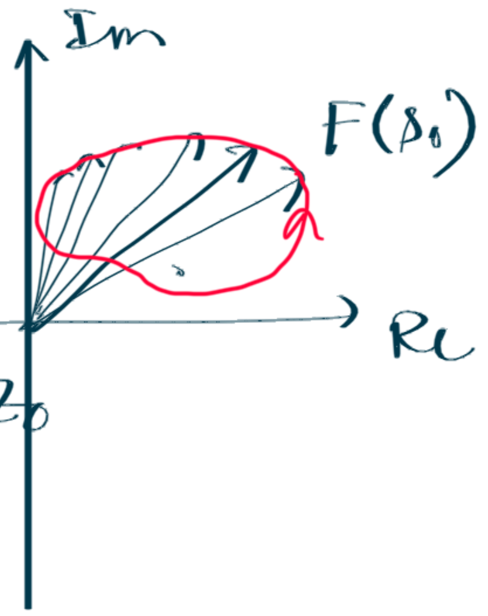




No. of encirclement of the origin is $N = -2$.

$$\boxed{N = Z - P}$$



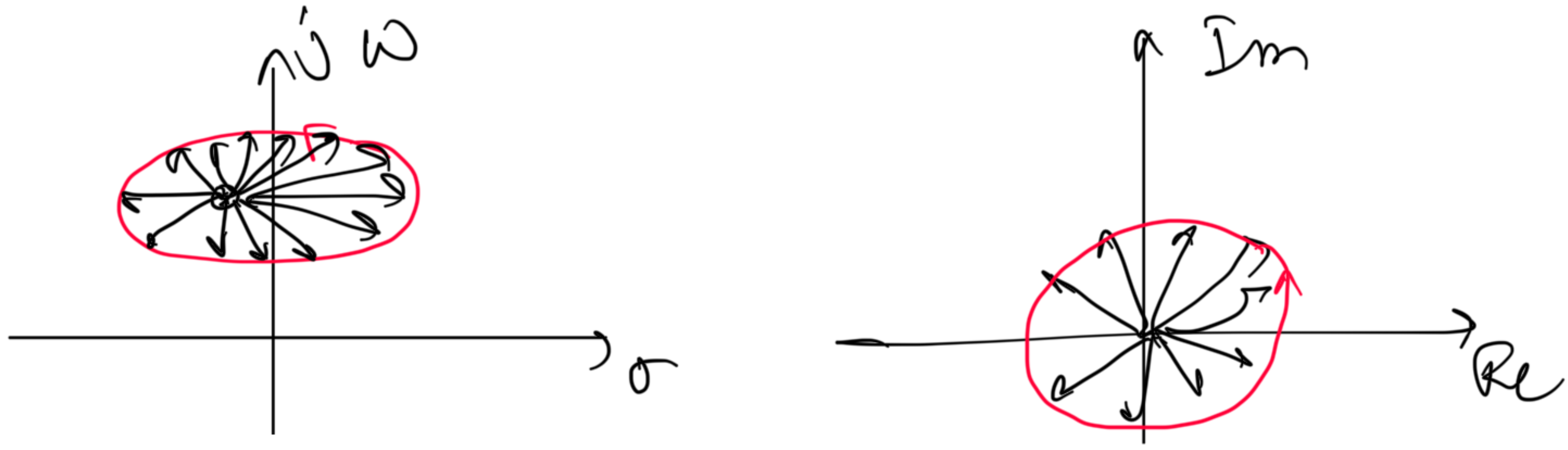


$$(s - z_0)\Big|_{s=s_0} = s_0 - z_0$$

C is the contour

$$F(s) = \frac{k(s-z_1)(s-z_2)\cdots(s-z_m)}{(s-p_1)(s-p_2)\cdots(s-p_n)}$$

$$F(s_0) = \frac{k(s_0-z_1)(s_0-z_2)\cdots(s_0-z_m)}{(s_0-p_1)(s_0-p_2)\cdots(s_0-p_n)}$$

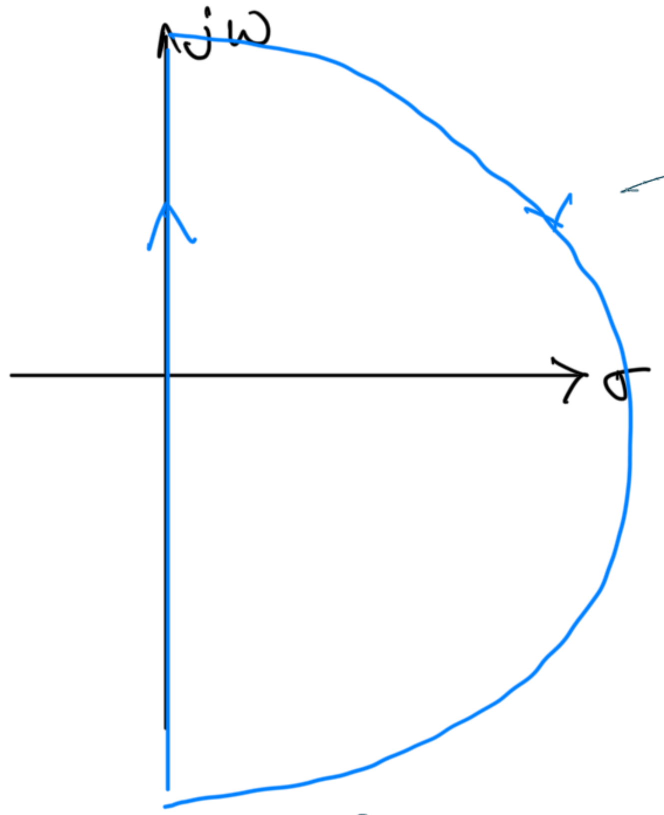


Closed loop TF = $\dfrac{KG(s)}{\left(1 + KG(s)H(s)\right)}$

Where are the closed-loop poles?

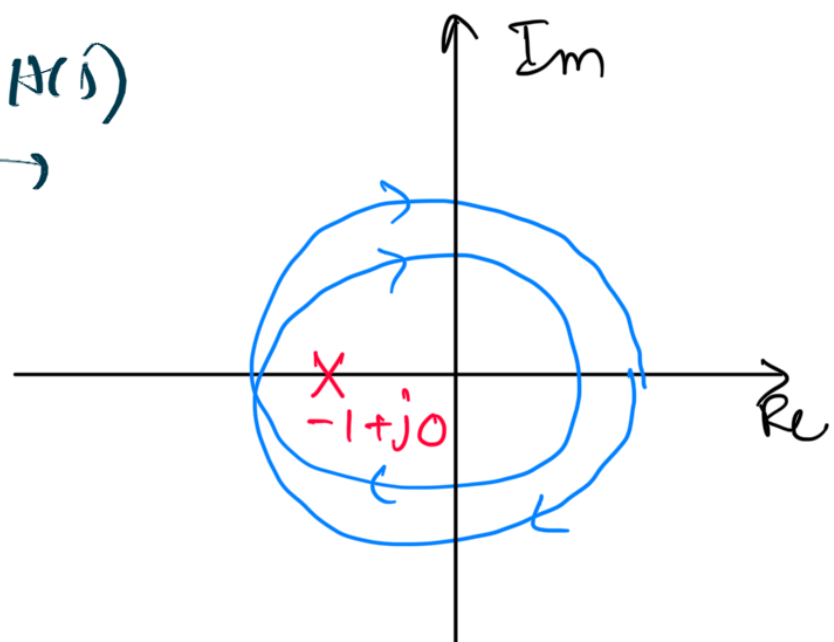
CL poles = zeros of $1 + KG(s)H(s)$

Stability of CL $\iff$ No zeros of $1 + KG(s)H(s)$ in $\overline{\mathbb{C}^+}$



Nyquist contour.

$KG(s)H(s)$



N is the no. of encirclements of the origin

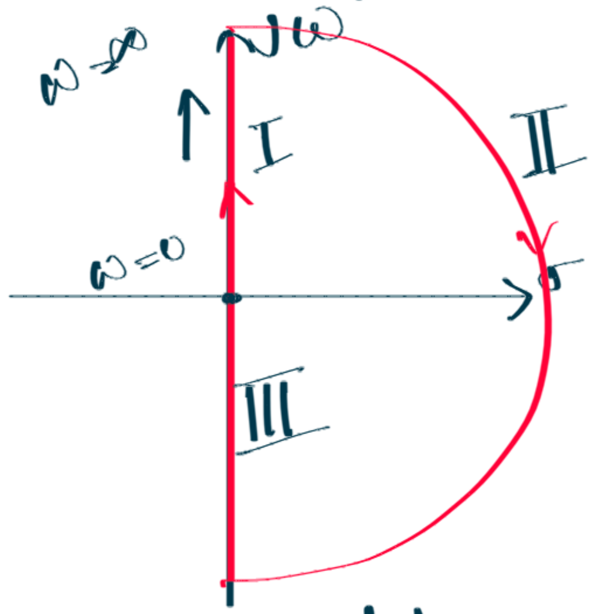
$$\boxed{N = P - Z}$$

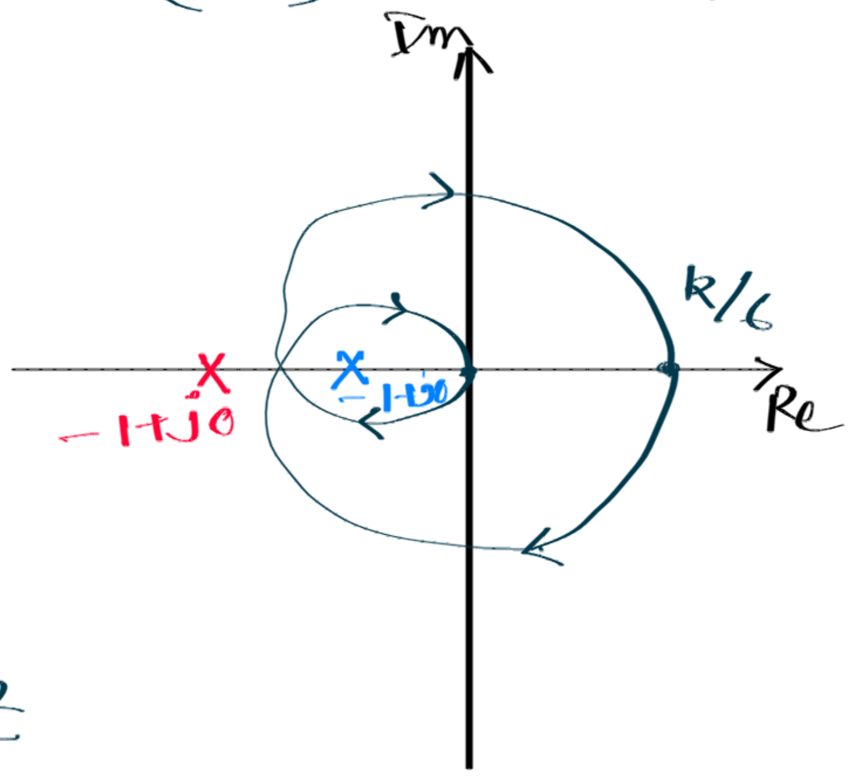
no of open loop poles in $\overline{\mathbb{C}^+}$

no. of closed loop poles in $\overline{\mathbb{C}^+}$

Example 6 $\quad kG(s)H(s) = \dfrac{k}{(s+1)(s+2)(s+3)}$

Open loop TF.





$N = P - Z$

$P = 0$

$0 = Z$ CL stable