EE2019

20/2/2018

3rd order: $L(s) = \frac{A(s)}{k} = \frac{A_0}{k} \frac{1}{\left(1+\frac{s}{p_1}\right)^3}$

Unstable: $\frac{A_0}{k} = 8$,

$\frac{V_o}{V_i}$: poles @ $\pm j\sqrt{3} \cdot p_1$

$L(j\sqrt{3}p_1) =$

$$H(s) = \frac{N(s)}{D(s)}$$

$$\frac{Y}{U} = \frac{G}{1 + GH} \qquad 1 + \underbrace{GH}_{\text{loop gain}} \qquad 1 + L$$

Closed loop transfer fn. $\frac{V_o}{V_i} = \frac{k}{1 + \text{[illegible]}} = \frac{k}{1 + \frac{1}{L(s)}}$

$$= \frac{k \cdot L(s)}{1 + L(s)}$$

has poles @ $\pm j\omega_o$

$$\boxed{L(\pm j\omega_o) = -1}$$

For the 3rd order case: $L(s) = \frac{A_0}{k} \cdot \frac{1}{\left(1+\frac{s}{p_2}\right)^3}$

If $\frac{A_0}{k} = 8$, $L(j\omega) = -1$ @ $\omega = \pm\sqrt{3}\,p_1$

$\Rightarrow$ Closed Loop transfer fn. which has $1 + L(s)$ in the denominator is ∞ @ $s = \pm j\sqrt{3}\,p_1$

$\Rightarrow$ Closed Loop TF has poles @ $\pm j\sqrt{3}\,p_1$

$L(j\omega) = -1 \Rightarrow |L(j\omega)| = 1, \; \& \; \angle L(j\omega) = -\pi$

Keep away from this

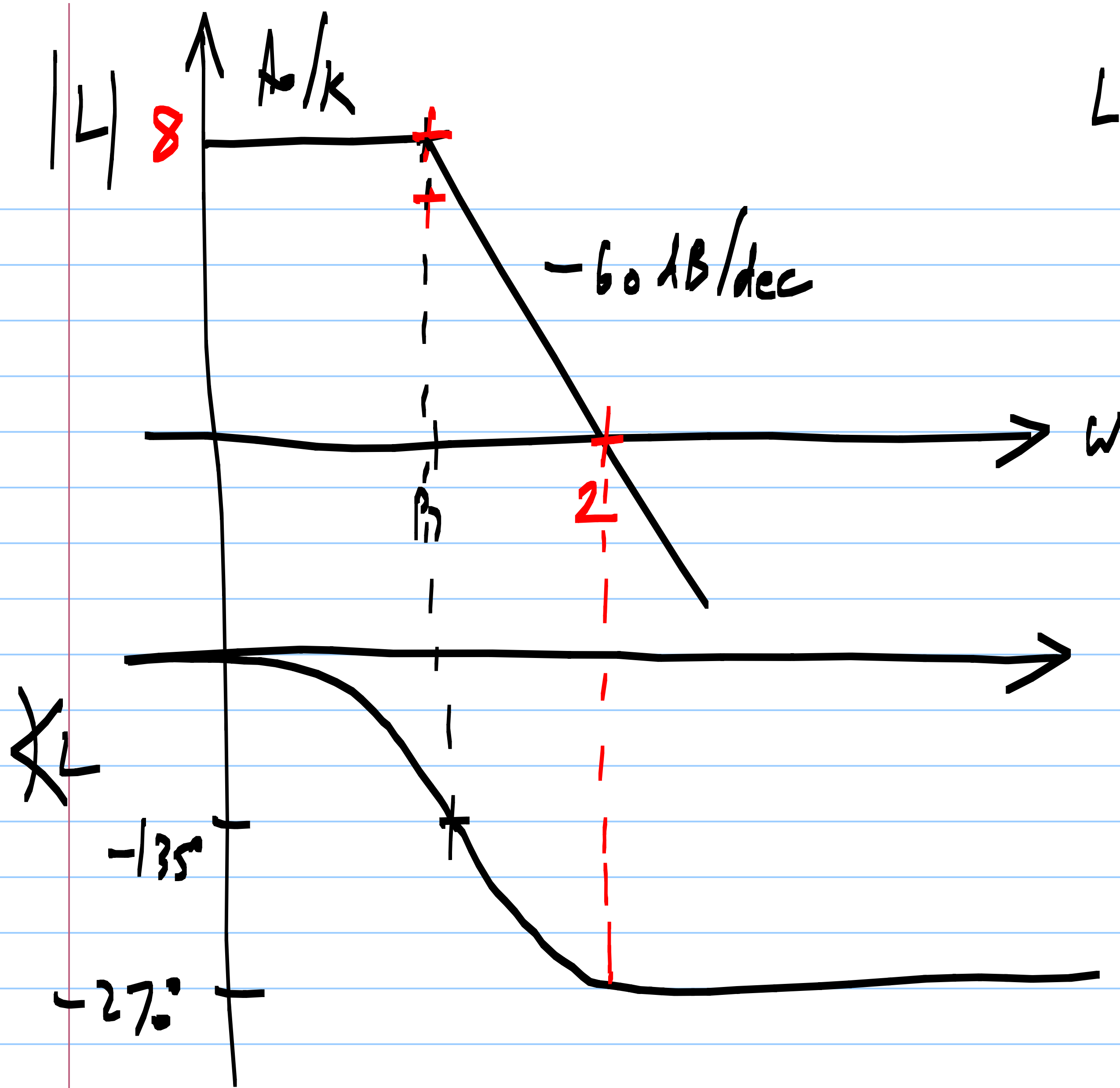
For stability: ($L(s)$ has only poles, no zeros)

When $|L(j\omega)| = 1$ $\quad \omega_{u,loop}$ unity loop gain freq.

Phase lag < 180° $\quad$ Phase should not be an -ve or -180°

$\underline{\phi(\omega_{u,loop}) + 180° = PM}$

$$L(s) = \frac{A_0}{k} \frac{1}{(1+s/p_1)^3}$$



$$\frac{V_o}{V_i} = \frac{N(s)}{D(s)} = \frac{(\quad)}{1 + L(s)} = \frac{(\quad)}{1 + \frac{N_L(s)}{D_L(s)}}$$

Poles: values of s for which $D(s) = 0$

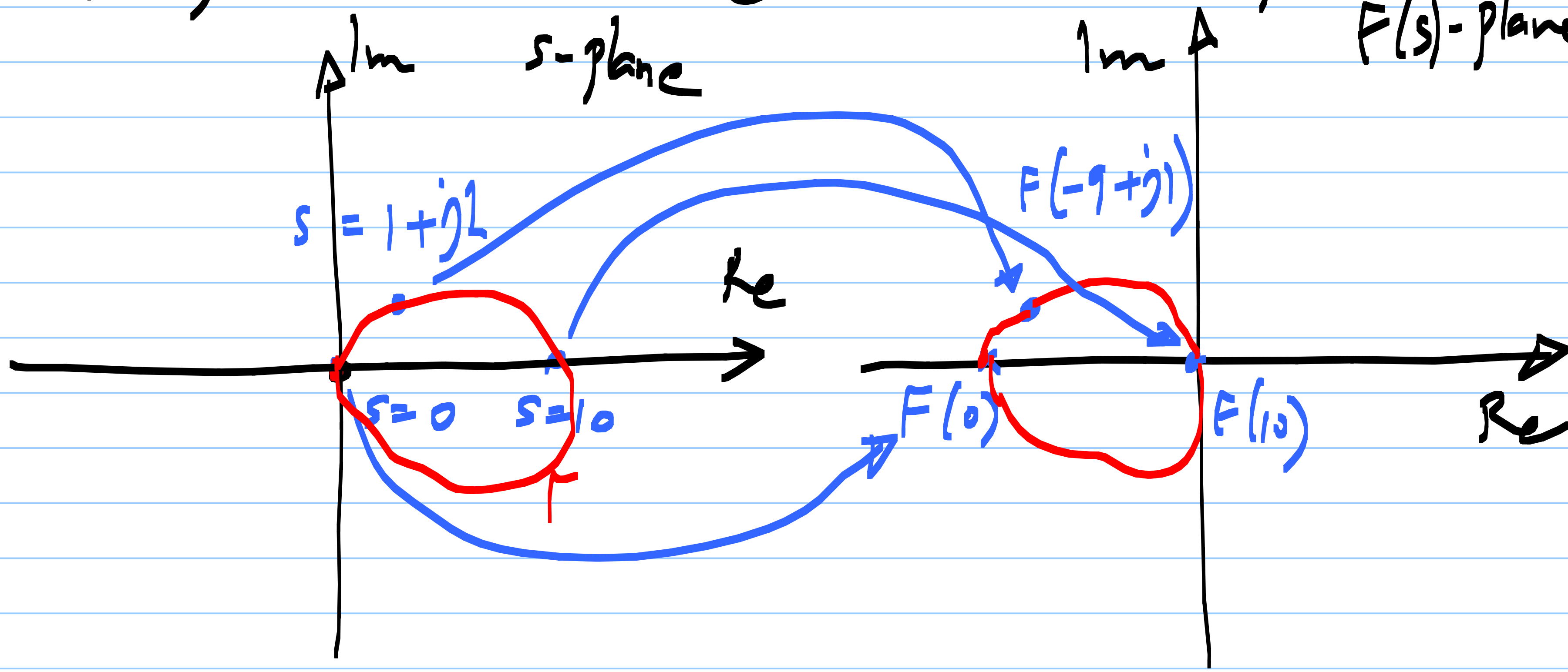
= values of s for which $L(s) = -1$

Complex function: $F(s) = (s-10)$

s: complex variable

$F(s)$: complex valued

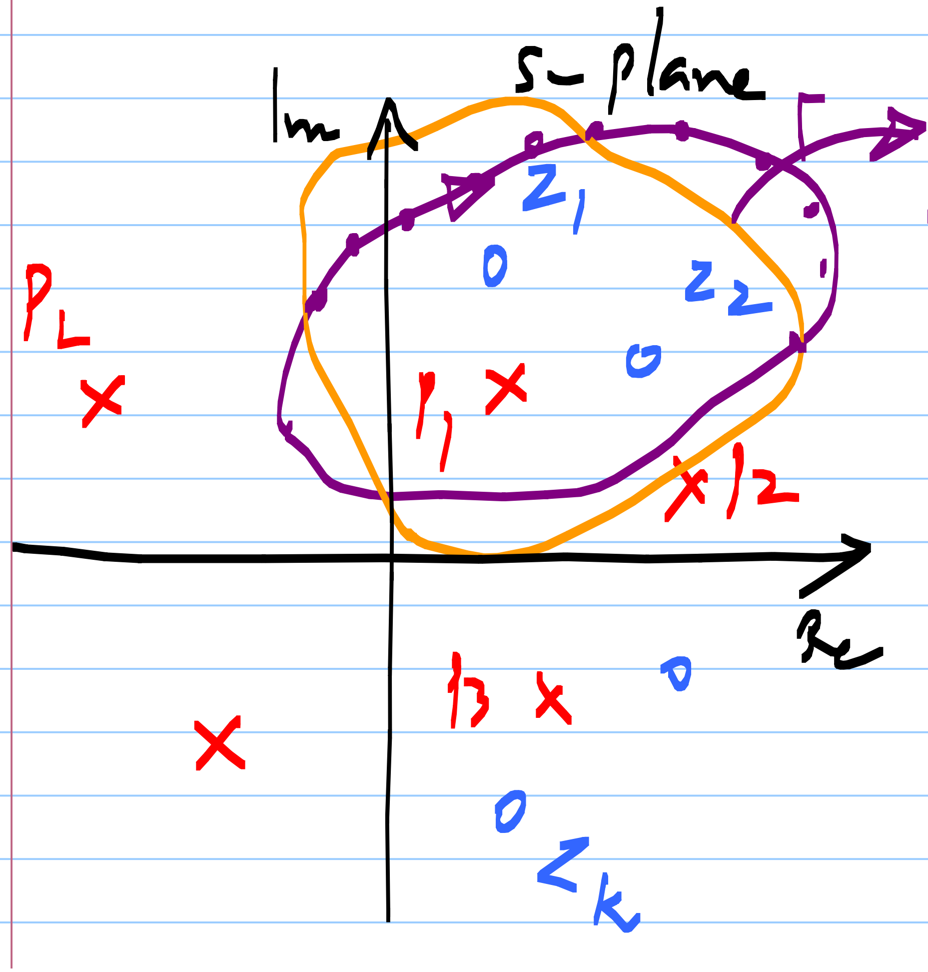
$F(s)$ has a zero @ $s = 10$

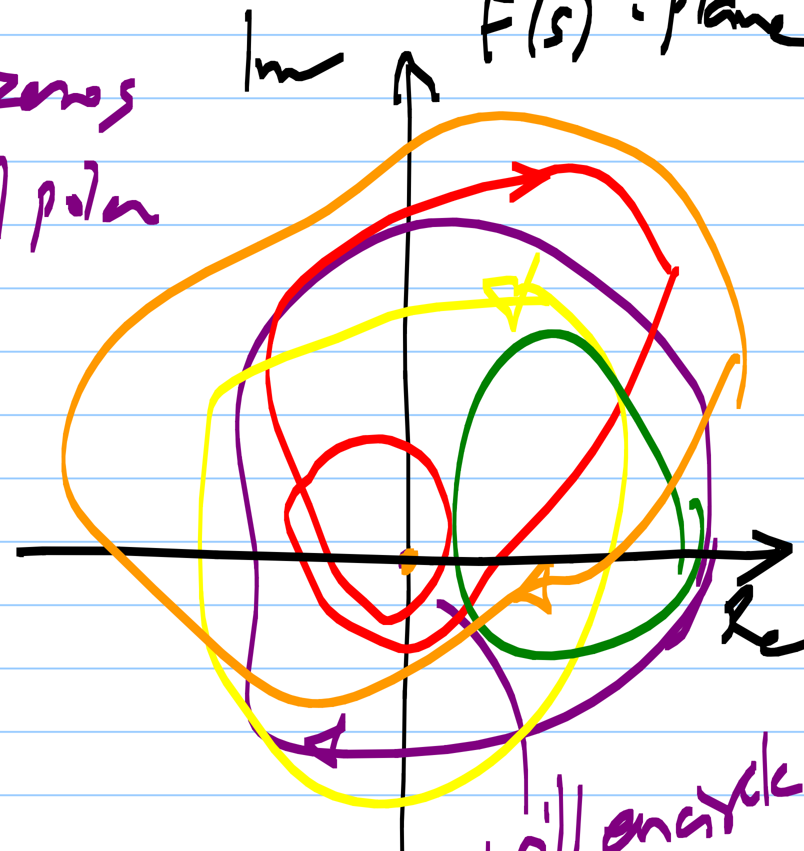


$$F(s) = k \cdot \frac{(s-z_1)(s-z_2)\cdots(s-z_k)}{(s-p_1)(s-p_2)\cdots(s-p_L)}$$

K zeros

L poles





will encircle the origin N−M