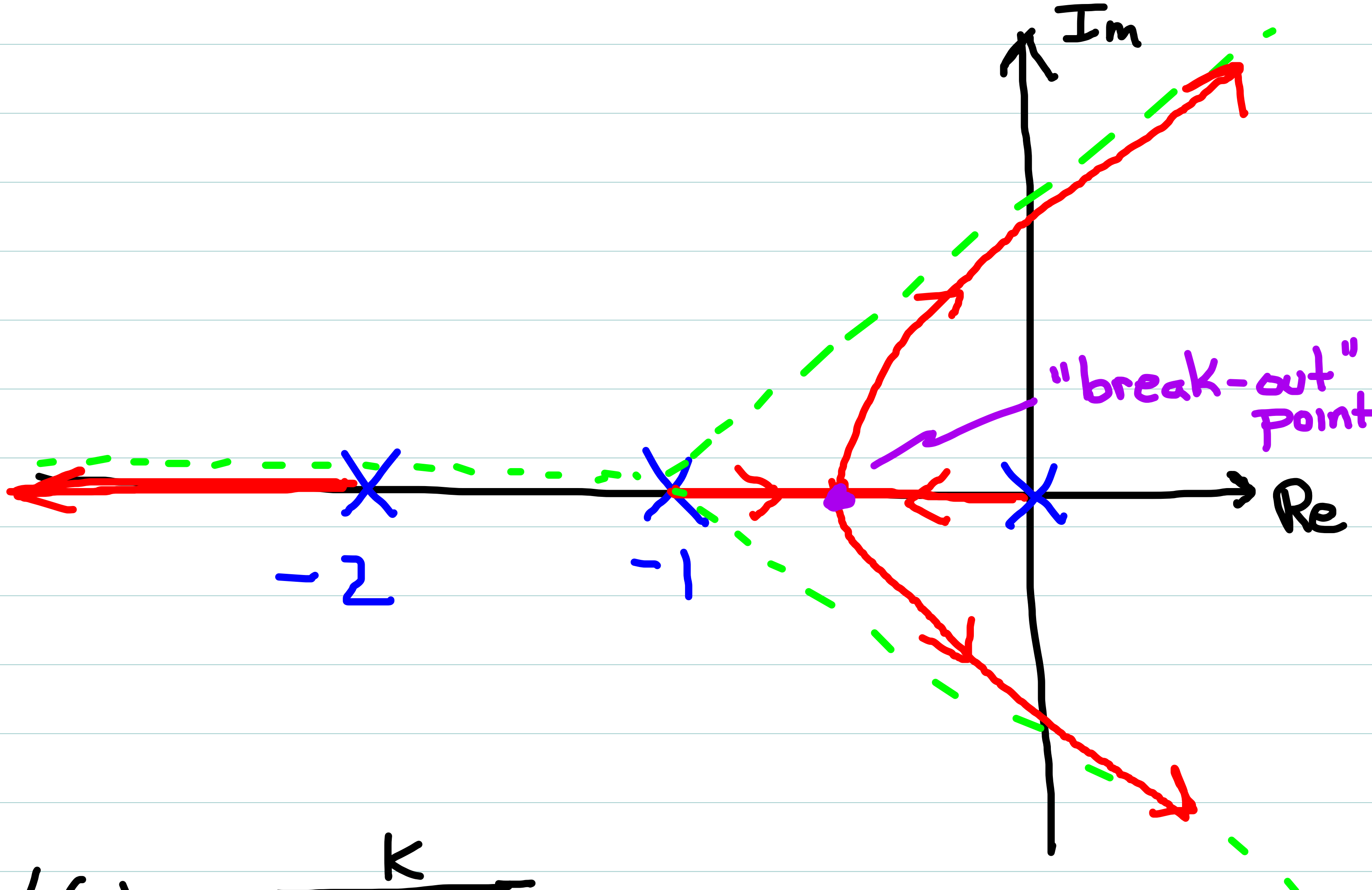
Example #5, cont



$$L(s) = \frac{K}{s(s+1)(s+2)}$$

<u>High Gain Instability</u>

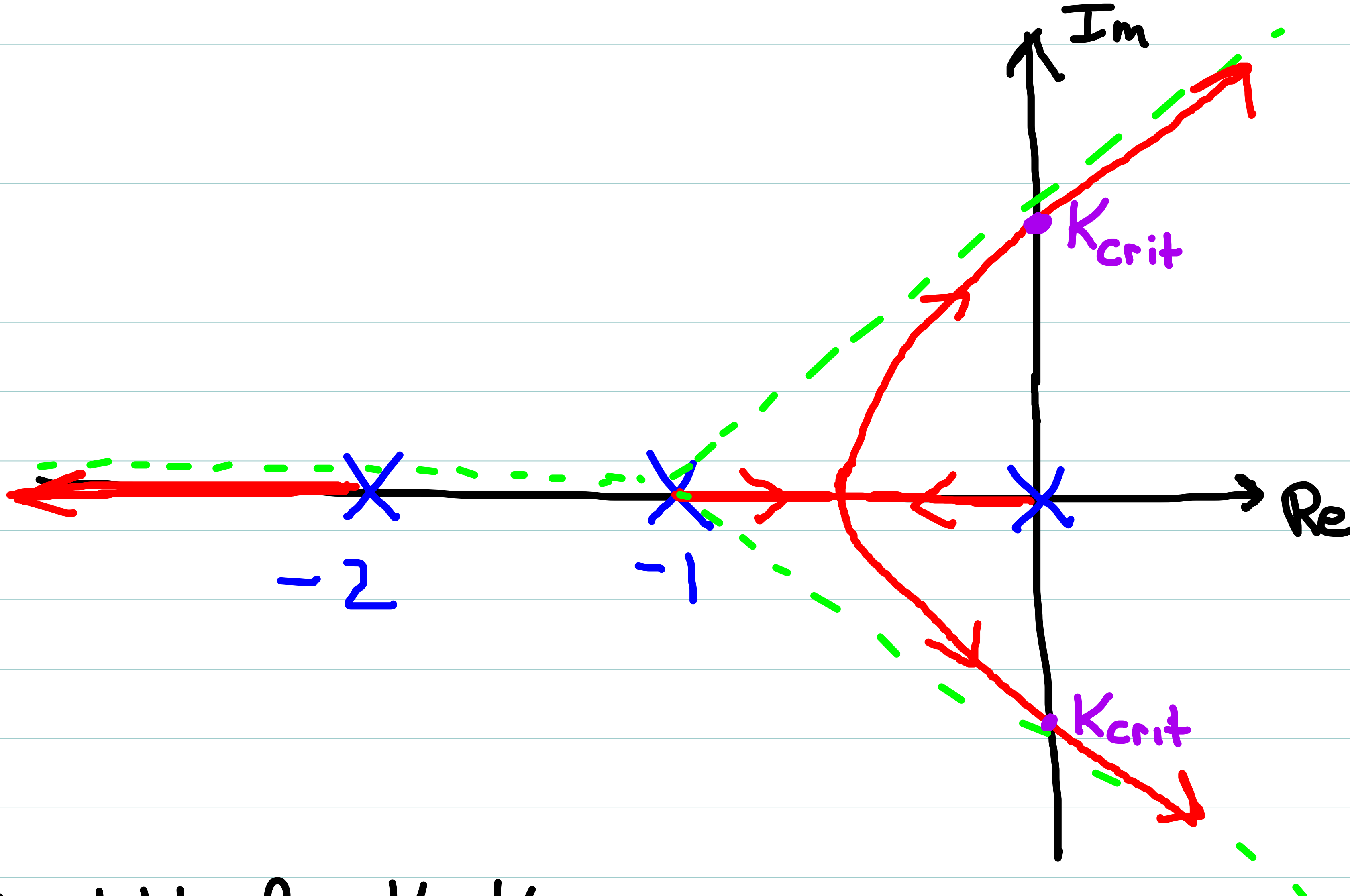
Since this example has asymptotes in RHP, we can see the CL system <u>will</u> be unstable for sufficiently high gains K.

Whether this is a problem or not depends on the gain we want/need to get the desired CL poles

$T(s)$ is <u>not</u> automatically unstable b/c the root locus branches in RHP!

Such a locus only tells us $T(s)$ will be unstable for <u>some</u> values of K.

Example #5, cont



Unstable for $K > K_{crit}$

Example #6

$$L(s) = \frac{K(s+3)}{(s+1)(s+2)}$$

$\Rightarrow n=2,\ m=1,\ n-m=1$

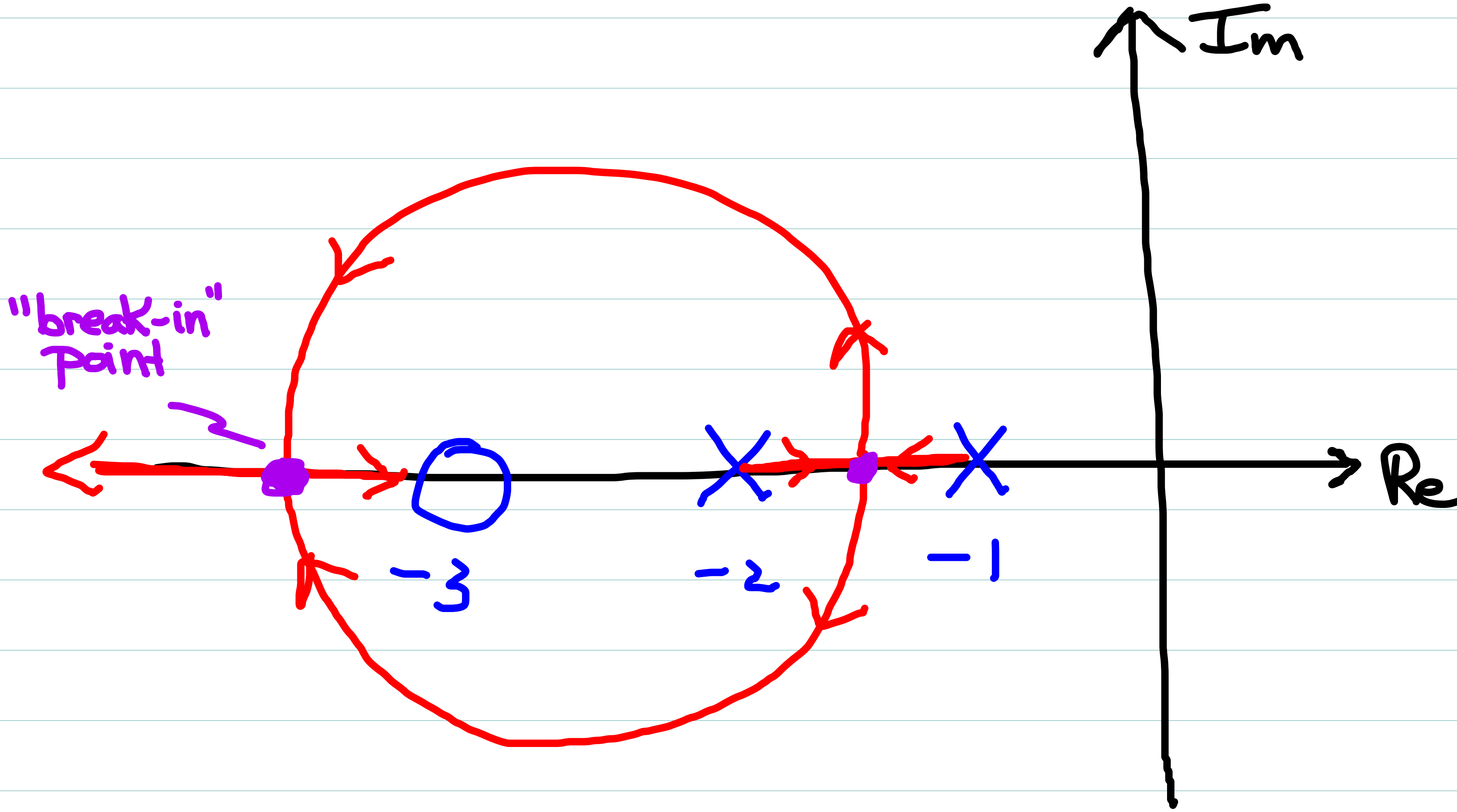
$\Rightarrow$ One branch ends at -3 (OL zero). One branch goes to ∞ along asymptote $\alpha = 180°$ (negative real axis)

$\Rightarrow$ Segments of branches lie on real axis:

$\Rightarrow$ Between -2 and -1

$\Rightarrow$ left of -3

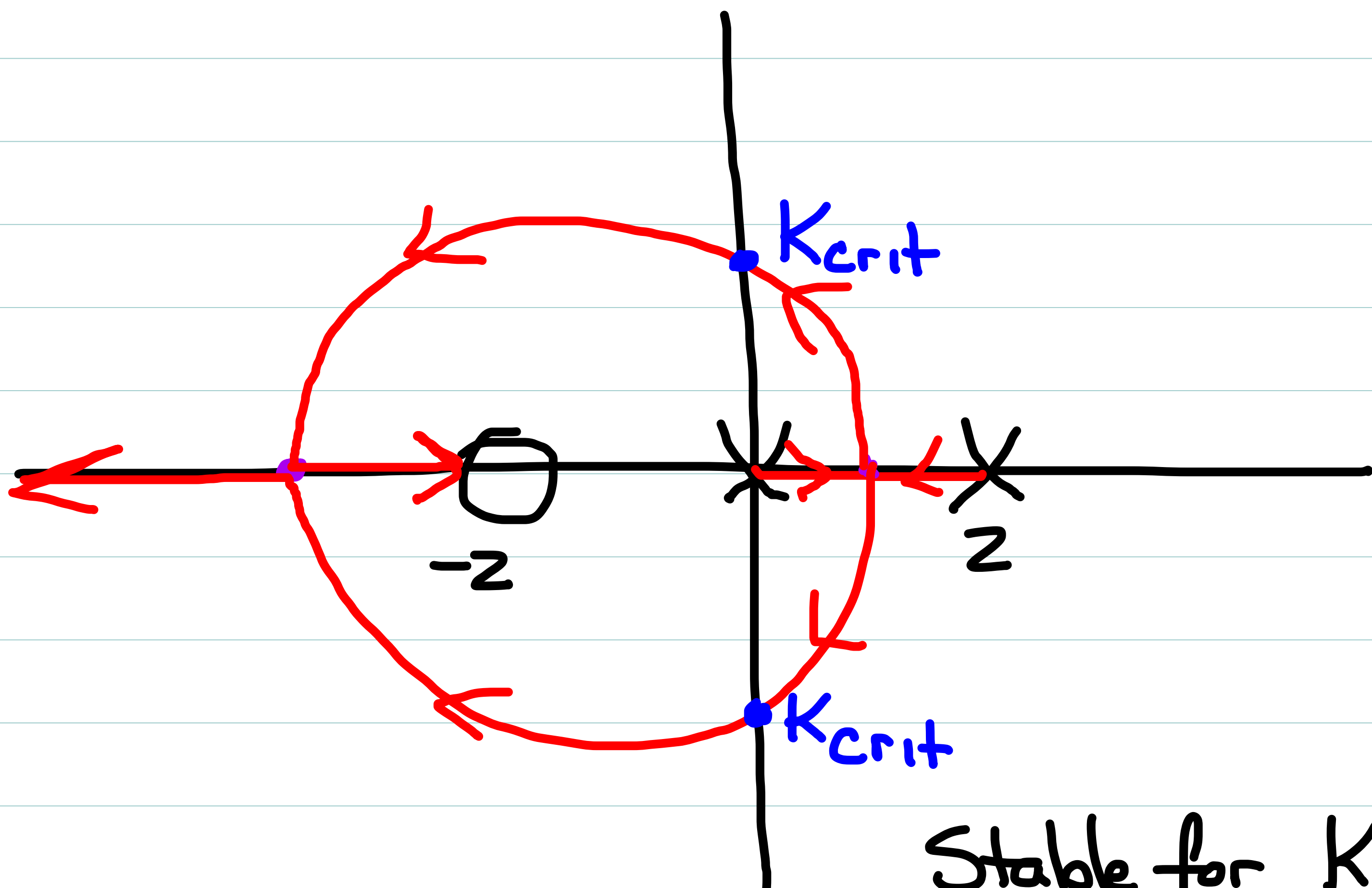
Example #6, cont



Example #7

$$L(s) = \frac{K(s+2)}{s(s-2)}$$

Similar analysis to above

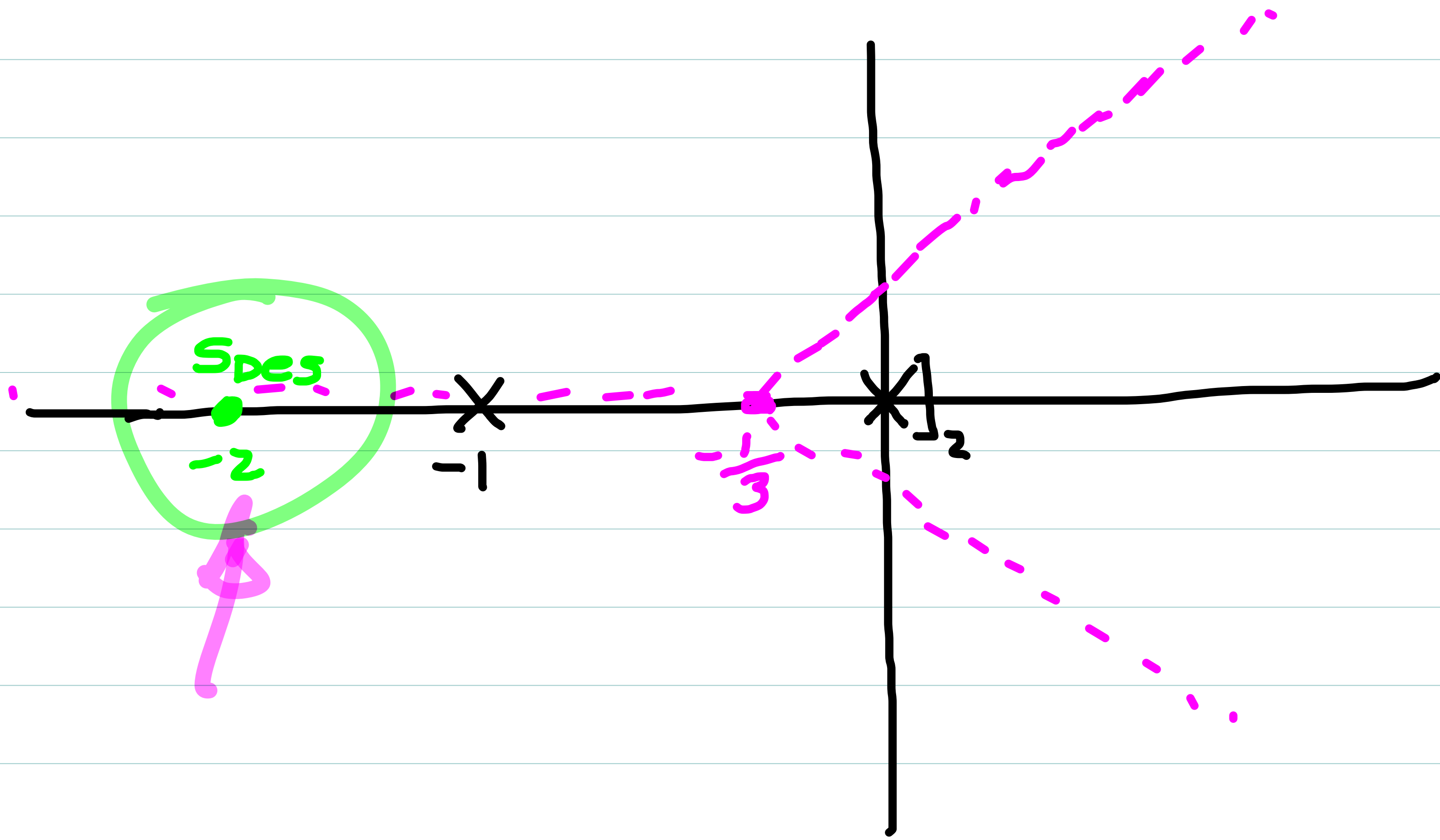


Stable for $K > K_{crit}$

Example #3

This is where we originally started our investigation

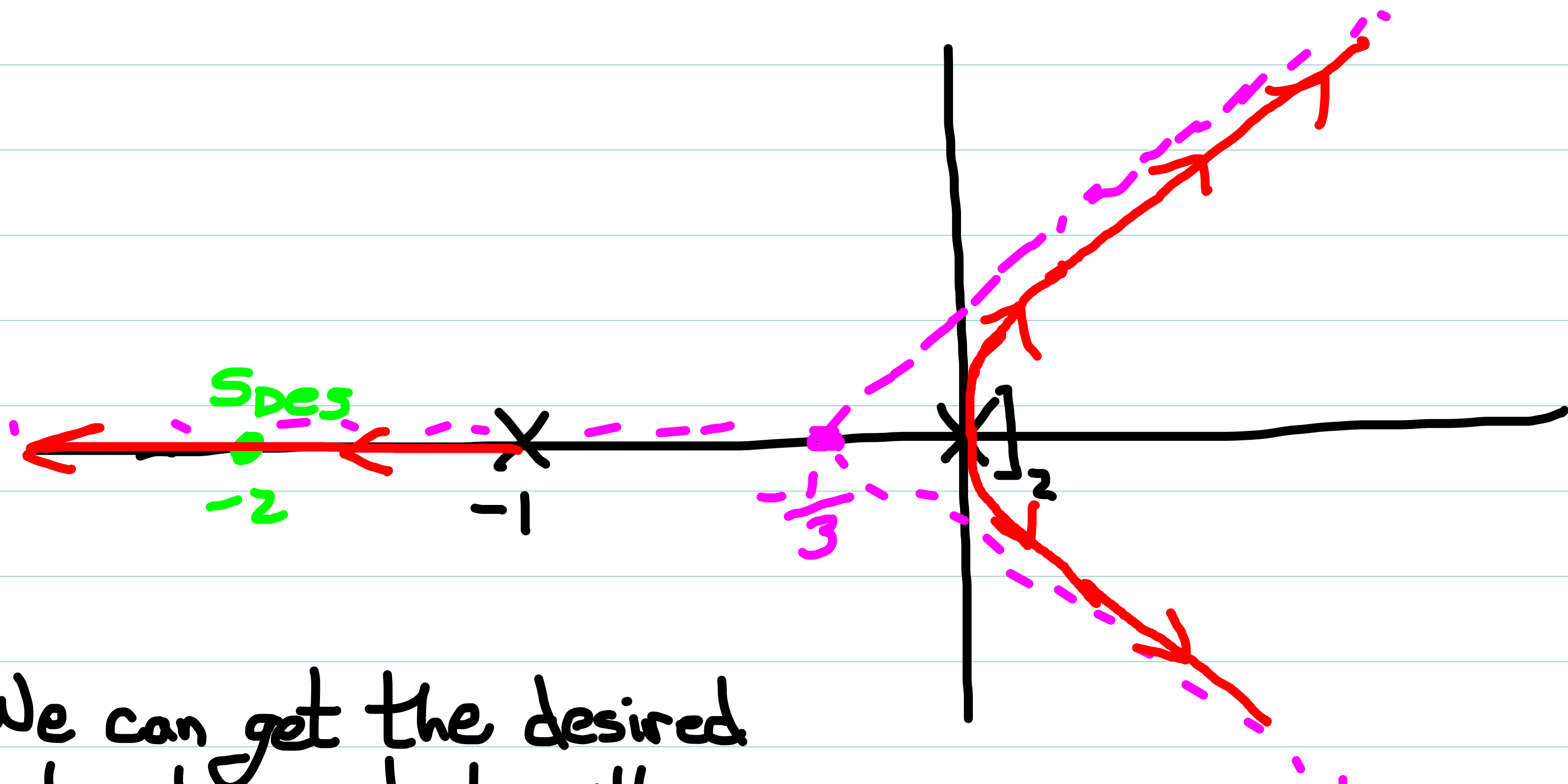
with $H(s) = K$, $L(s) = \dfrac{K}{s^2(s+1)}$



Example #3

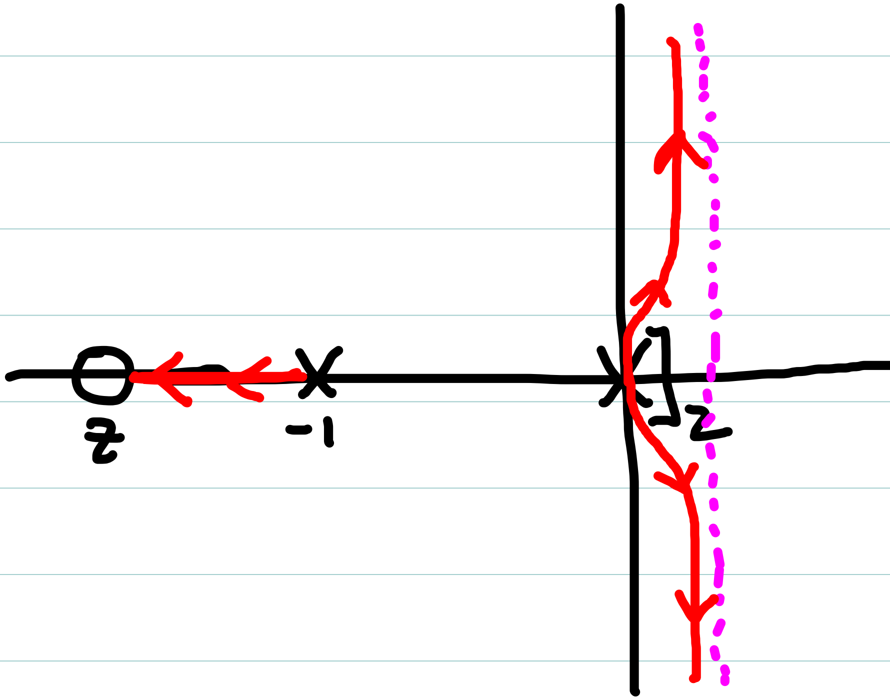
This is where we originally started our investigation

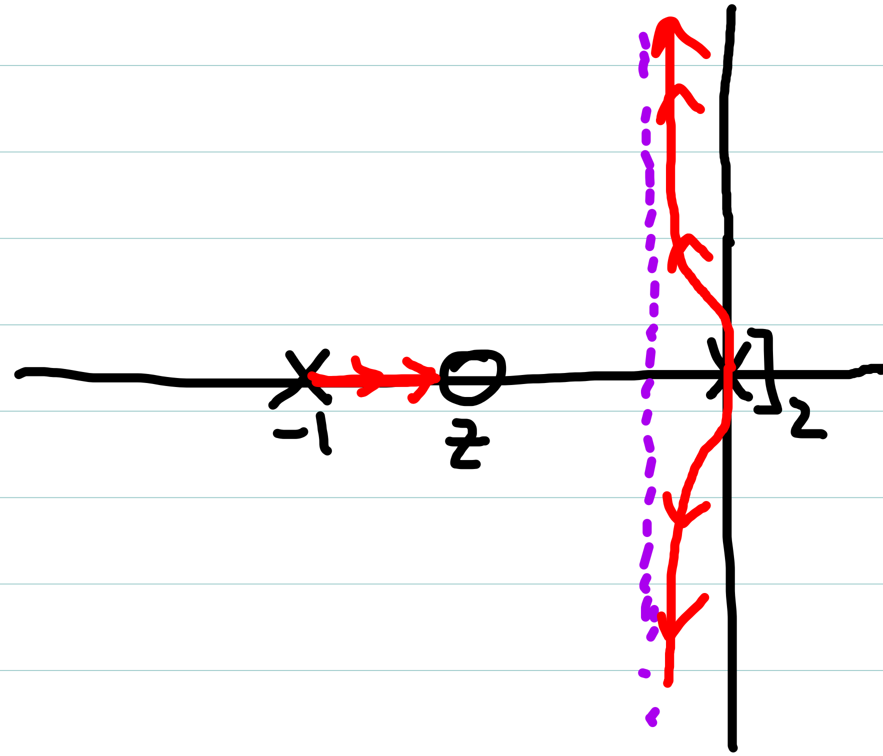
$$L(s) = \frac{K}{s^2(s+1)}$$



We can get the desired pole at -2, but will inevitably have poles of $T(s)$ in RHP

With instead $H(s) = K(s-z)$





$z < -1 \Rightarrow \alpha_\ell = \pm 90°$

$\sigma_a = \frac{-1}{2}(1+z) > 0$

$0 < z < -1$

$\Rightarrow \sigma_a < 0$

So, with $H(s) = K(s-z)$ we can stabilize the system as long as $|z| < 1$ (which would agree with a Nyquist/phase margin analysis)

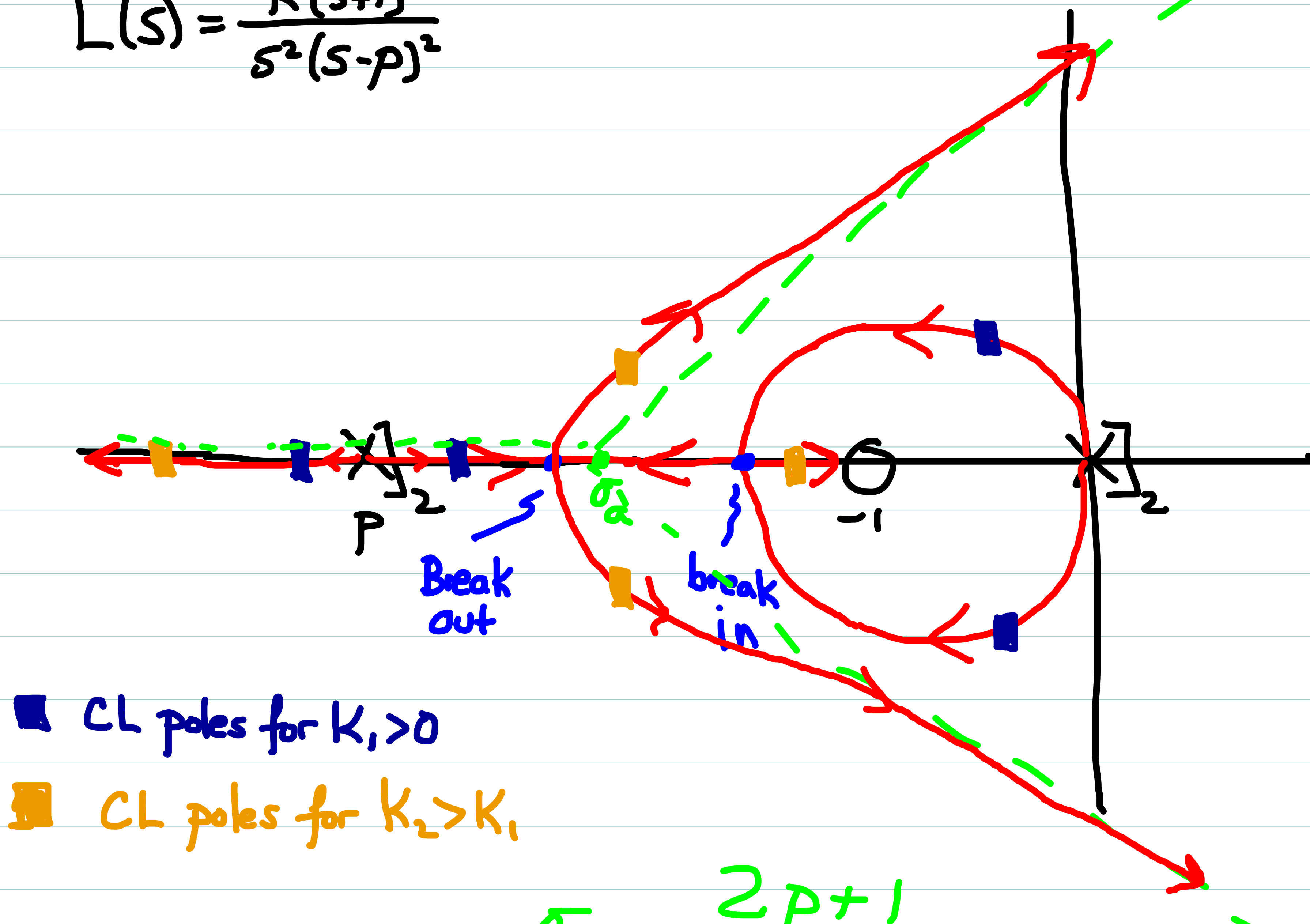
<u>But</u> we would have to accept a real pole > -1, and moreover this pole would not be dominant

An implementable compensator which could allow a real dominant CL pole near -2 would be

$$H(s) = K\left[\frac{(s+1)^2}{(s-p)^2}\right]$$

which has an interesting locus (next page)

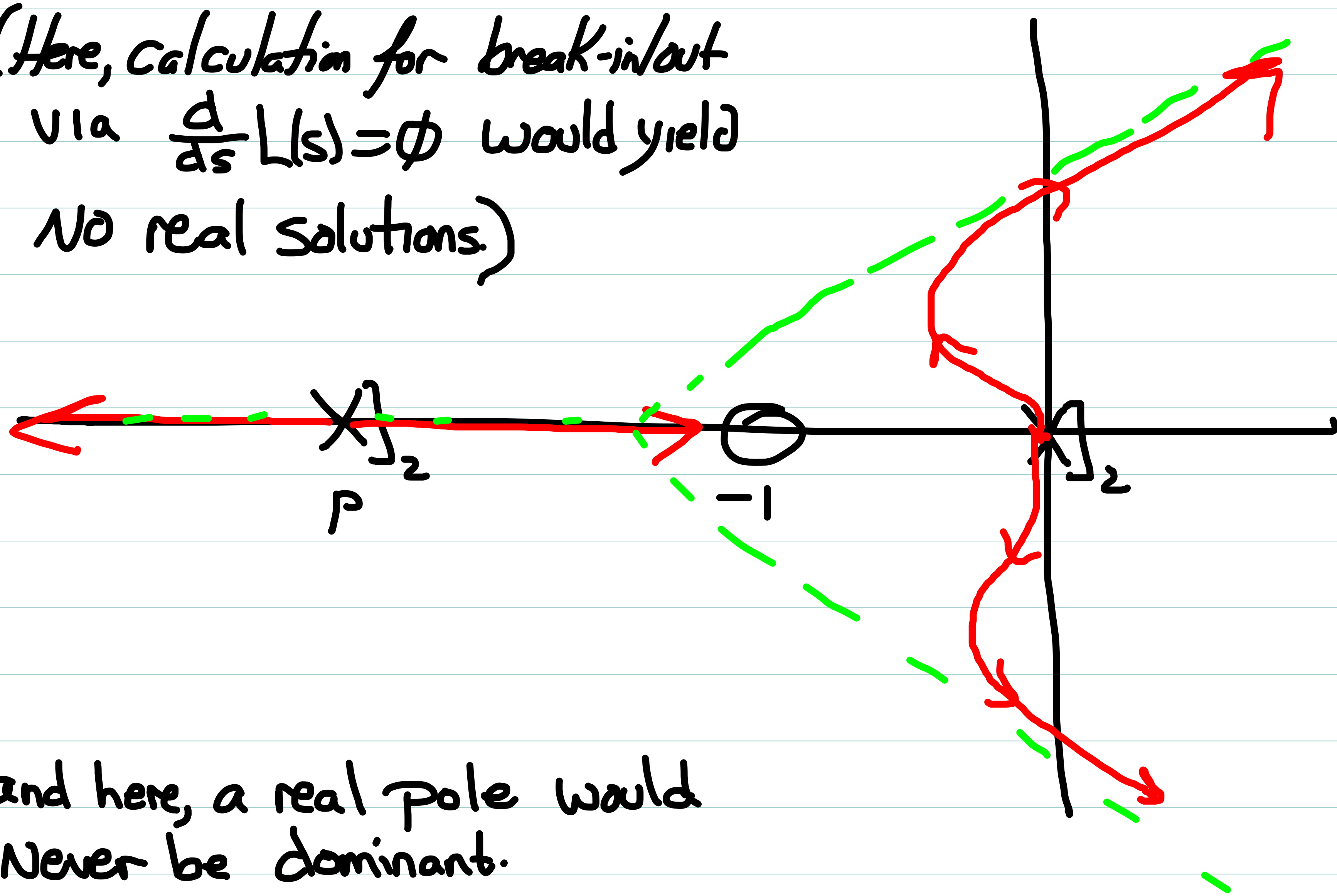
$$L(s) = \frac{K(s+1)}{s^2(s-p)^2}$$



$$\sigma_a = \frac{2p+1}{3}$$

However, depending on exact value of p, this is also possible:

(Here, calculation for break-in/out via $\frac{d}{ds}L(s) = \phi$ would yield NO real solutions.)



and here, a real pole would Never be dominant.

Comments on root locus method

⇒ Rules are not determinative; there may be many locus shapes consistent with calculations (although Matlab rlocus command will show you an exact plot).

⇒ Cannot adapt method to account for effects of time delay

⇒ Can adapt method only for very simple kinds of robustness analysis.

⇒ Bode/Nyquist methods preferred in professional practice.

⇒ But root locus does provide useful additional insights which are not available using freq. methods

⇒ Familiarity with both gives "best of both worlds"