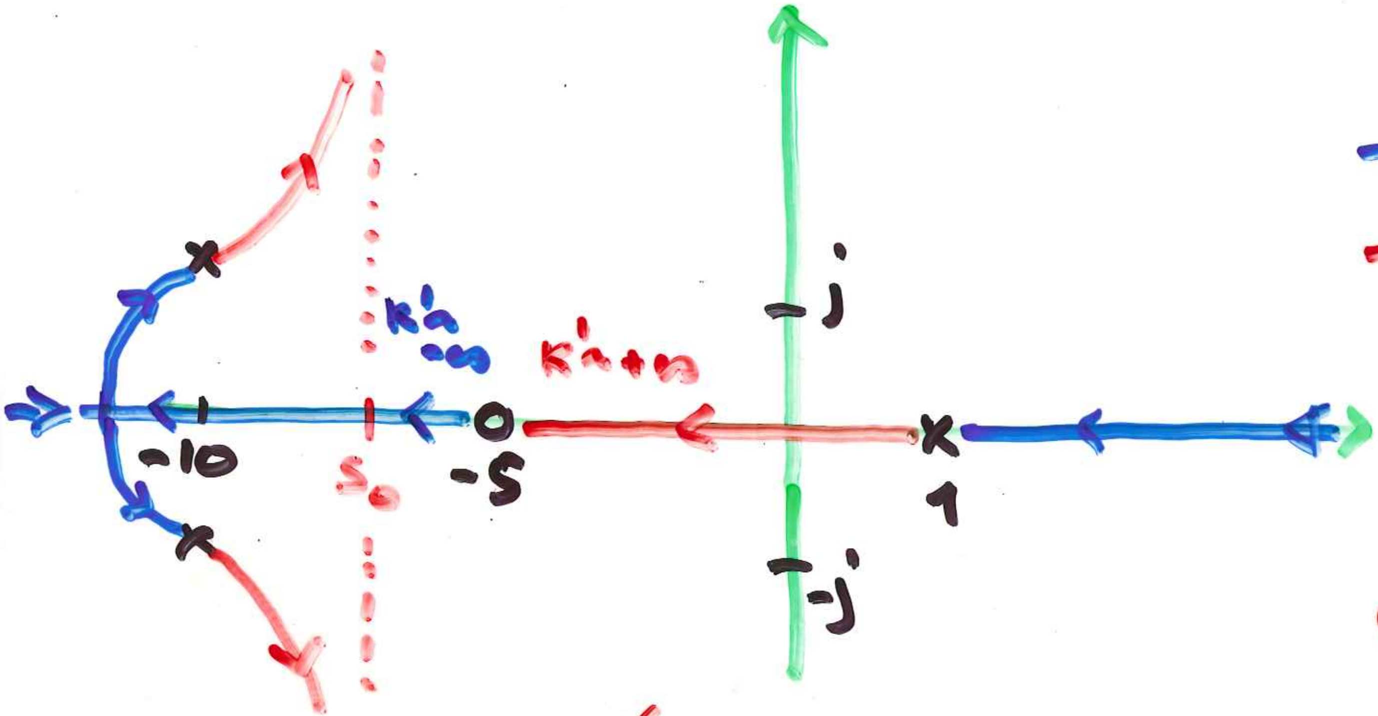
ex 1

$$F(s) = \frac{(s+5)\cdot k'}{(s+10+j)(s+10-j)(s-1)} = \frac{k'(s+5)}{(s-1)(s^2+20s+101)}$$



— = L.N

— = L.P.

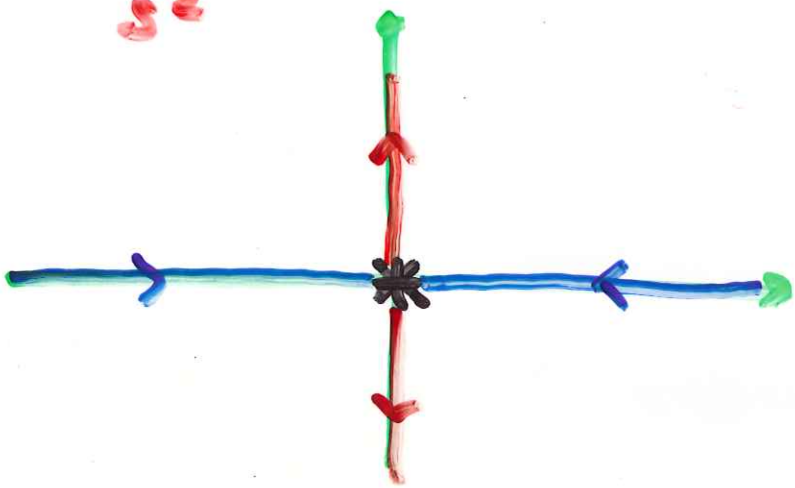
n = 3

m = 1

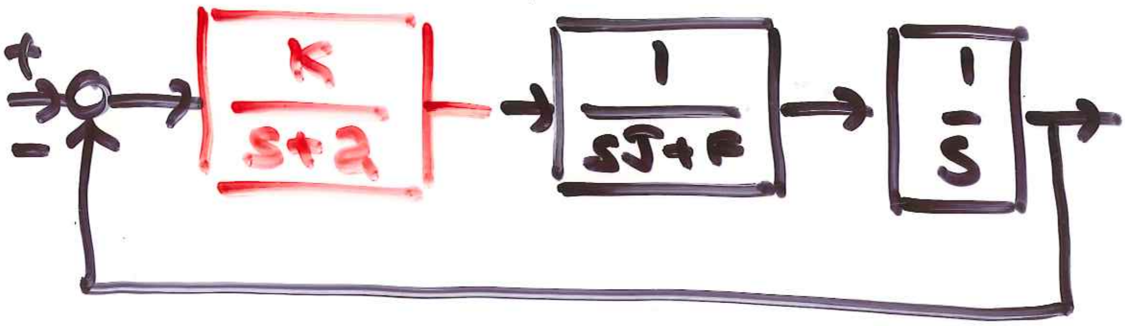
$$s_0 = \frac{1 - 10 + j - 10 - j - (-5)}{2} = -7$$

ex. 2

$$F(s) = \frac{k'}{s^2}$$

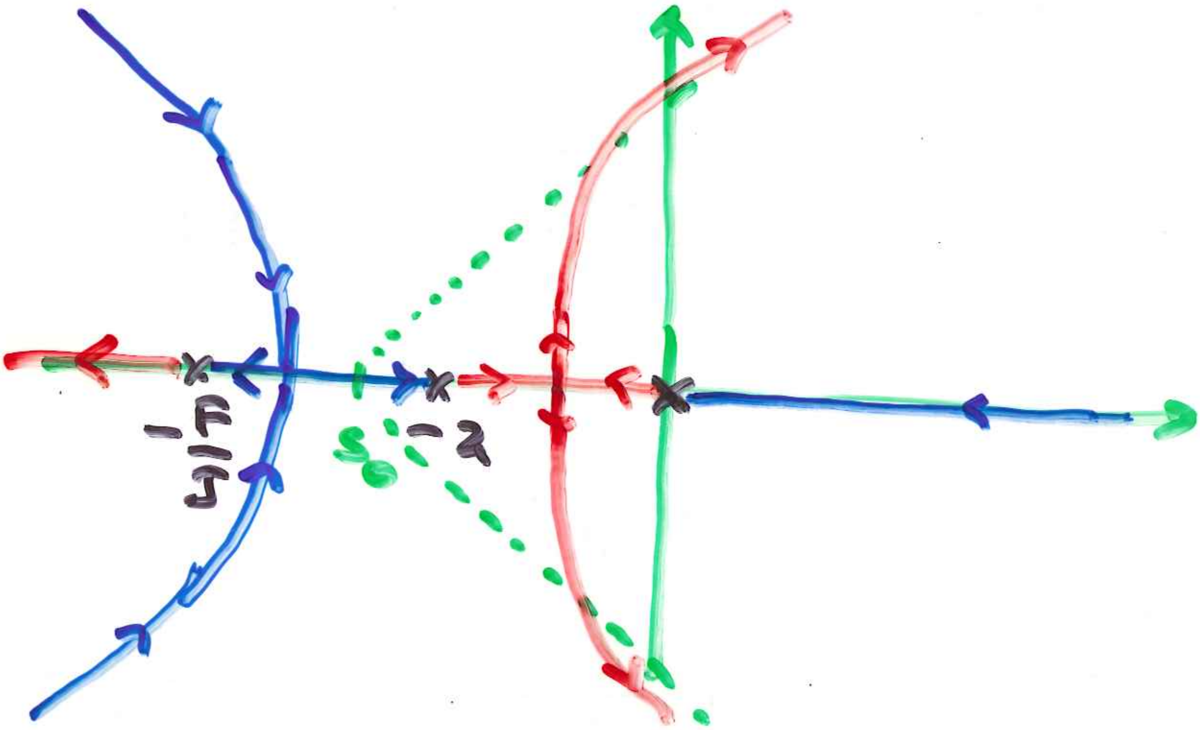


ex.3



$$F(s) = \frac{K}{s(sJ+F)(s+2)} = \frac{K/J = k'}{s(s+2)\left(s+\frac{F}{J}\right)}$$

$$f(s,k') = s(s+2)\left(s+\frac{F}{J}\right) + k' = 0$$



$$s_0 = \frac{-2-\frac{F}{J}}{3}$$

stabilità asintotica per

$0 < k' < K'_{max}$

Routh per ricavare K'_{max}

$$f(s, k') = s^3 + \left(a + \frac{F}{J}\right)s^2 + \frac{2F}{J}s + k'$$

tabella

3	1	$\frac{2F}{J}$
2	$a + \frac{F}{J}$	k'
1	$\bigcirc$	
0	k'	

$$\bigcirc = \frac{\frac{2F}{J}\left(a + \frac{F}{J}\right) - k'}{a + \frac{F}{J}} > 0$$

$$0 < k' < \frac{2F}{J}\left(a + \frac{F}{J}\right) \triangleq k'_{max}$$

$k' = \frac{K}{J}$

ex (a casa)

$$C(s) = \frac{K}{s+a}$$

$$PID(s) = K_P + \frac{K_I}{s} + \frac{K_D s}{1 + \varepsilon s}$$

$= ?$

Controllore

$$\frac{K}{s+a} = \frac{K/a}{1+\frac{1}{a}s}$$

visto come PID

$$\frac{K_I}{s} + K_p + \frac{K_D s}{1+\tau s}$$

Ponendo $\boxed{K_I = 0}$, dall'uguaglianza

$$\frac{K/a}{1+\frac{1}{a}s} = \frac{K_p(1+\tau s) + K_D s}{1+\tau s}$$

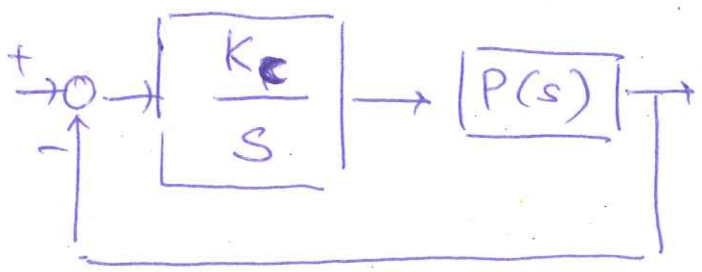
si ha

$$\boxed{\tau = 1/a}$$

$$\boxed{K_p = K/a}$$

$$\boxed{K_D = -K_p\tau = -K/a^2}$$

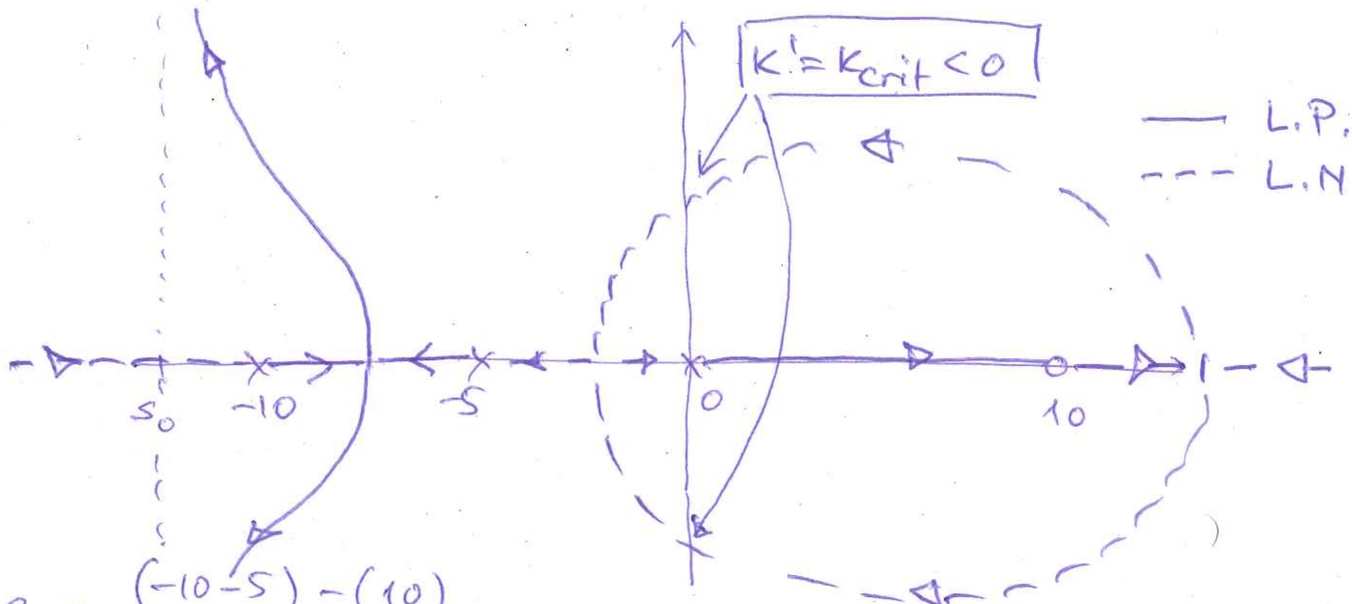
ex 4



$$P(s) = \frac{2(s-10)}{(s+5)(s+10)}$$

$$K_p = -0.4$$

$$F(s) = \frac{(2K_c)(s-10)}{s(s+5)(s+10)} \qquad 2K_c = K'$$



$$s_0 = \frac{(-10-5)-(10)}{2} = -12.5$$

- L.P. sempre instabile (un ramo "intrappolato" tra [0 ÷ 10]

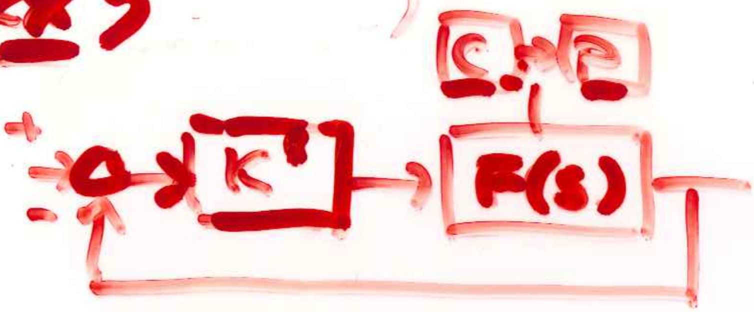
- L.N. potenzialmente stabile → per $|K'| = 2|K_c|$ sufficientemente piccolo (e $K' < 0$)

  ↓

  $K_{crit} < K' < 0$

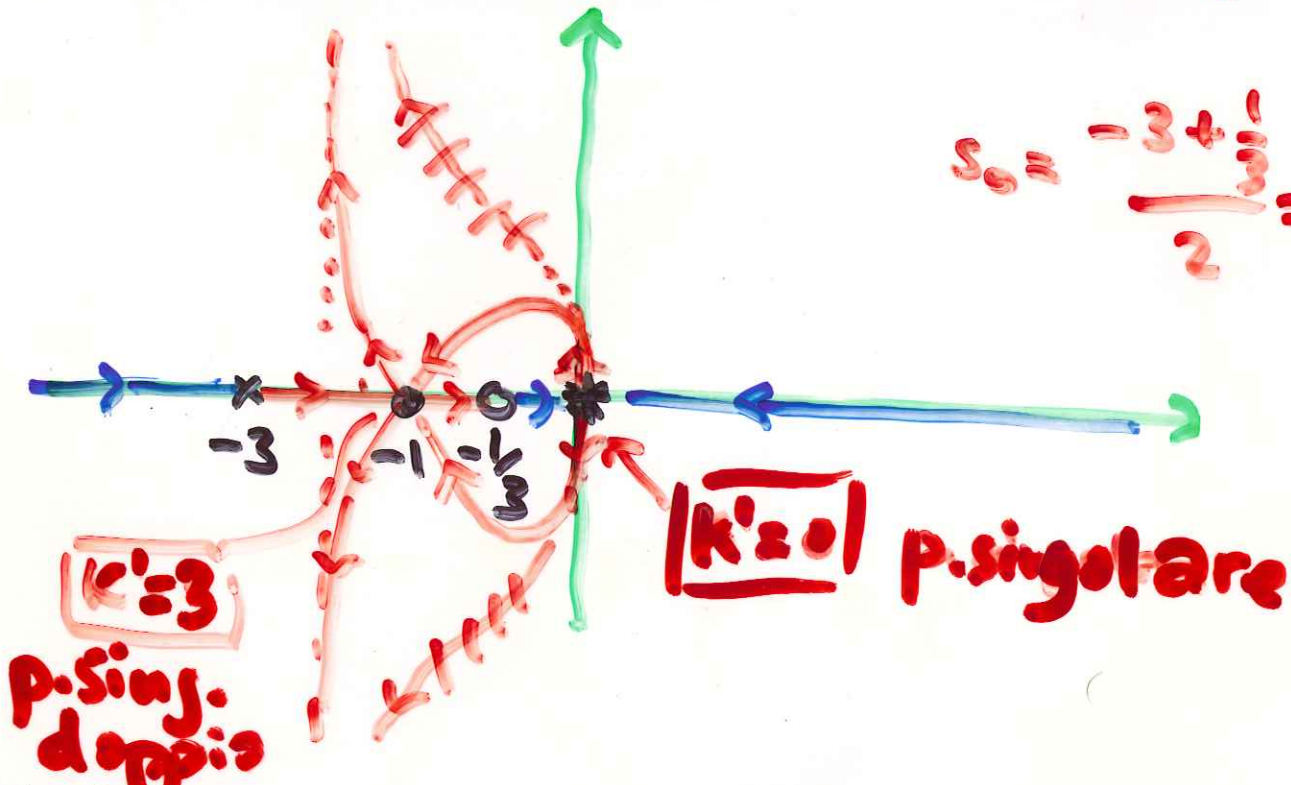
- non è detto che questo sia compatibile con una specifica per il regime permanente che richieda $|K_c| >$ valore minimo

ex 5



$$F(s) = \frac{s+\frac{1}{3}}{s^2(s+3)}$$

$$s_0 = \frac{-3+\frac{1}{3}}{2} = -\frac{4}{3}$$



calcolo dei punti singolari

$$\begin{cases} f(s,k') = s^2(s+3) + k'(s+\frac{1}{3}) = 0 \\ \frac{df}{ds}(s,k') = 3s^2+6s+k' = 0 \end{cases}$$

$$\frac{d^2f}{ds^2} = 6s+6 = 0 \rightarrow s=-1$$

$$[k' = -3s^2-6s]$$

$$\Rightarrow s^3+3s^2-3s^3-6s^2-s^2-2s = 0$$

$$-2s^3-4s^2-2s = -2s(s^2+2s+1) = 0 \quad (s+1)^2$$

$k'=0 \leftarrow s=0 \qquad s=-1 \rightarrow k'=3$