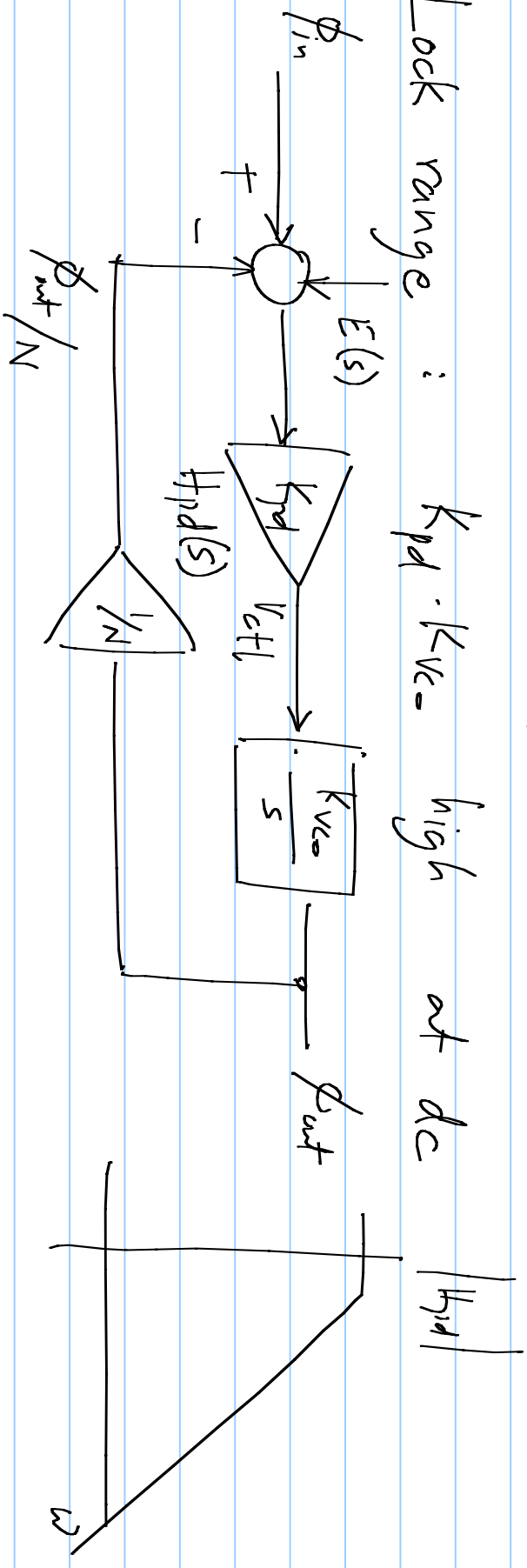
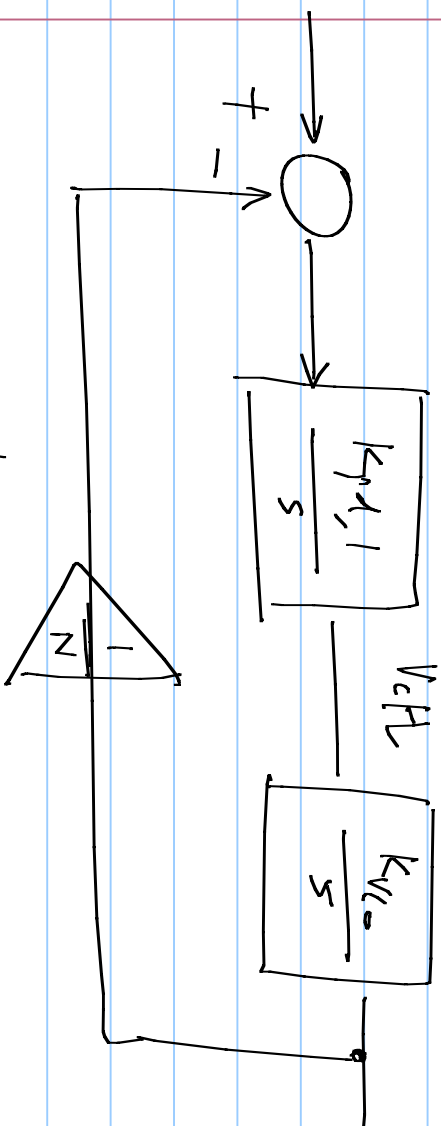


Reference feed through - VCO gets modulated by freq

Lock range : $K_{pd} \cdot K_{vc0}$ high at dc



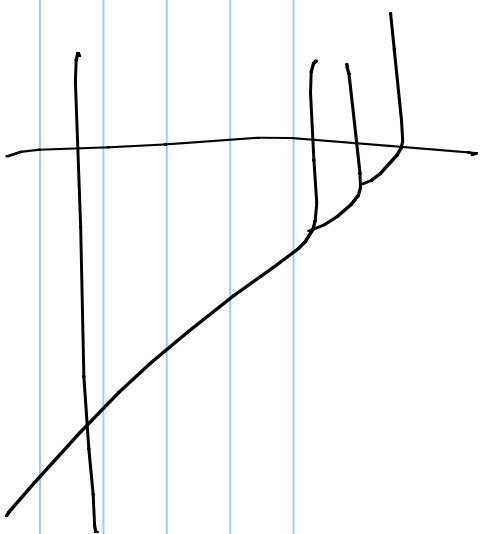
$$H_{p,d}(s) = \frac{K_{p,d,1}}{s}$$



$$H_{p,d}(s) = \frac{K_{p,d}}{1 + s/\omega_{p,d}}$$

$$L(s) = \frac{K_{p,d}}{1 + s/\omega_{p,d}} \cdot \frac{K_{v,c,0}}{s} \cdot \frac{1}{N}$$

$$1 + L(s) = \frac{\left[\left(\frac{s^2}{\omega_{p,d} \cdot K_{p,d} K_{v,c,0}} + \frac{s \cdot N}{K_{p,d} K_{v,c,0}} + 1 \right) \right]}{(1 + s/\omega_{p,d}) \cdot s \cdot N}$$



$$D(s) = \frac{s^2 \cdot N}{K_{pd} \cdot K_{vco} \cdot \omega_{pd}} + \frac{s \cdot N}{K_{pd} \cdot K_{vco}} + 1$$

$$as^2 + bs + c$$

$$\omega_p = \sqrt{\frac{c/a}{a}}, \quad Q_p = \frac{\sqrt{ac}}{b}$$

$$\omega_p = \sqrt{\frac{K_{pd} \cdot K_{vco} \cdot \omega_{pd}}{N}}, \quad Q_p = \frac{\sqrt{N / (K_{pd} K_{vco} \omega_{pd})}}{N / (K_{pd} K_{vco})}$$

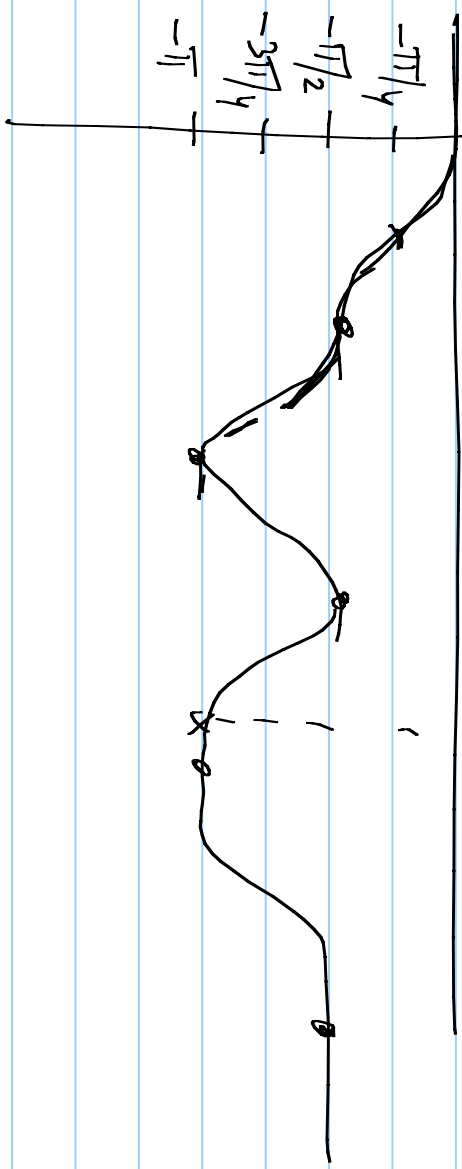
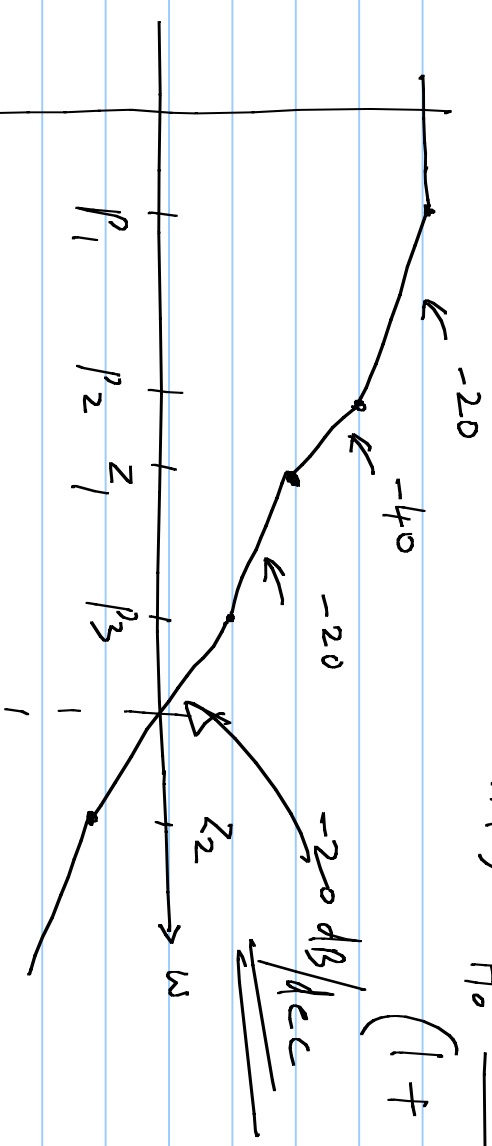
Large K_{pd} , small ω_{pd} :

Higher Q_p

$$= \sqrt{\frac{K_{pd} K_{vco}}{N \cdot \omega_{pd}}}$$

Bode plots are:

$$H(s) = H_0 \frac{(1 + s/z_1)(1 + s/z_2)}{(1 + s/p_1)(1 + s/p_2)(1 + s/p_3)}$$

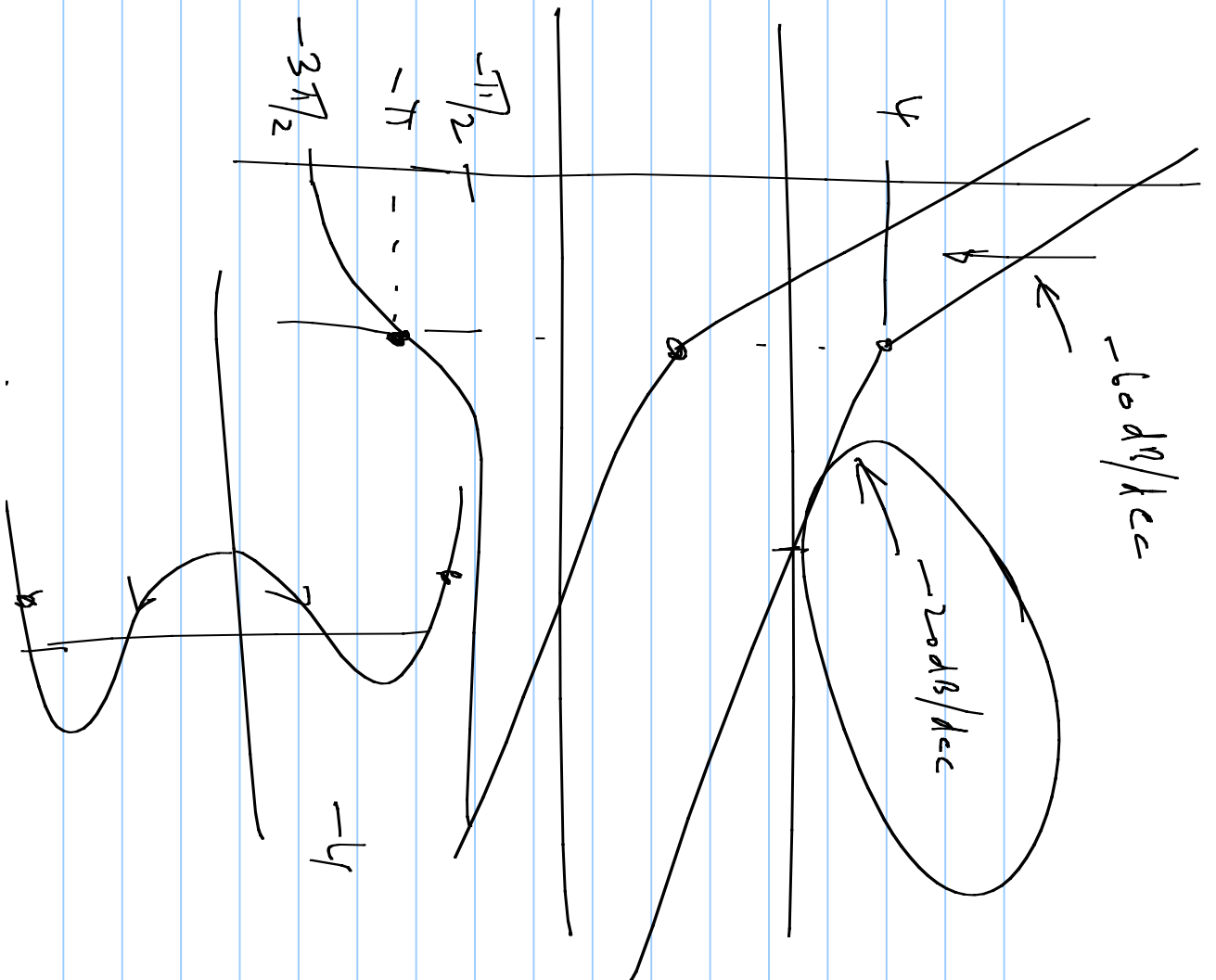


Stability: LHP
zeros

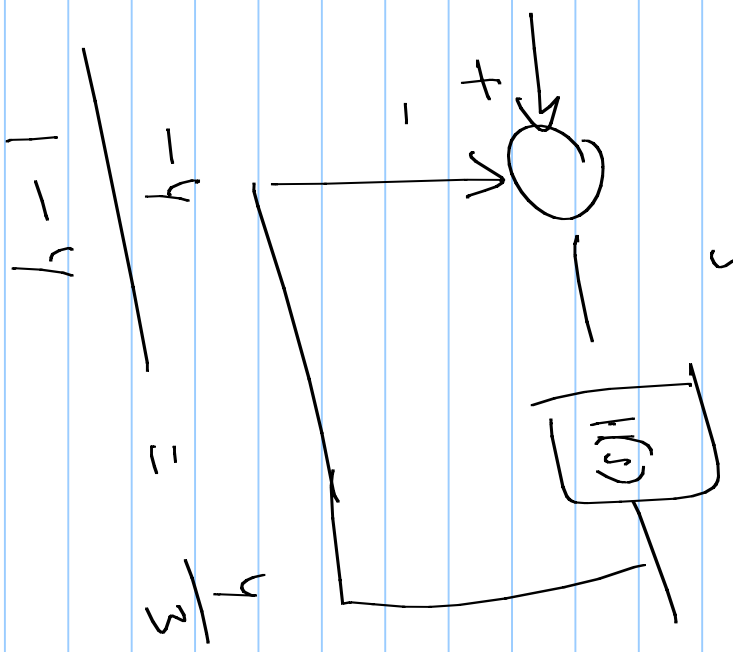
poles - # zeros

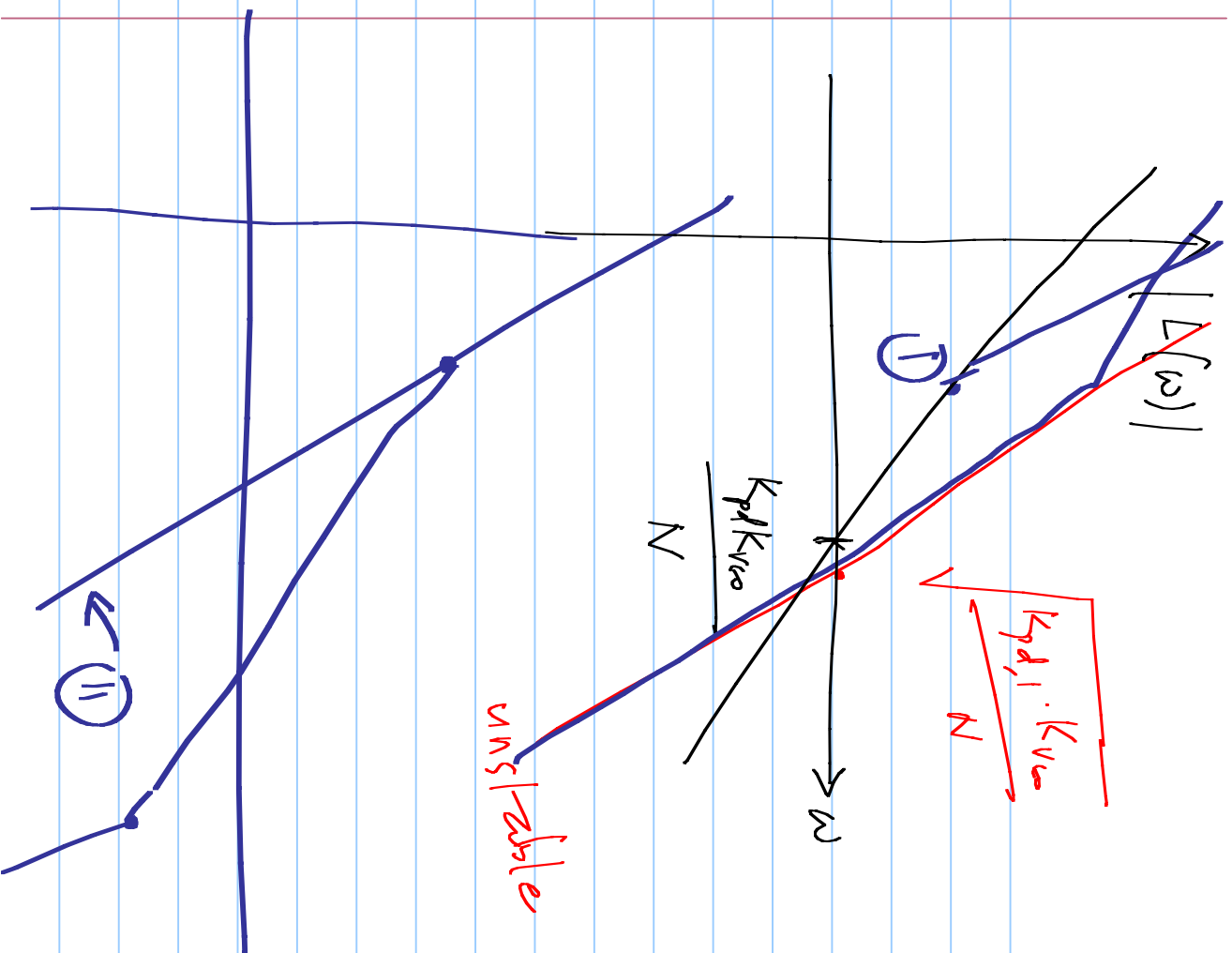
before unity

gain freq. = 1



$$K \cdot \frac{(1+s)^2}{s^3}$$





$$\textcircled{I} \quad K_{pd} \cdot \frac{K_{vco}}{s} \cdot \frac{1}{N}$$

$$\textcircled{II} \quad \frac{K_{pd,1}}{s} \cdot \frac{K_{vco}}{s} \cdot \frac{1}{N}$$

$$\frac{K_{pd,large} \cdot K_{vco}}{1 + \frac{s}{\omega_{pd}}} \cdot \frac{1}{s} \cdot \frac{1}{N}$$

$$H_{closed\ loop} = H_{ideal} \cdot \frac{L}{1+L}$$

$$K_{pd,1/s} \cdot \frac{K_{vco}}{s}$$

$$|L| \gg 1 \quad H_{ideal}$$

$$|L| \ll 1 \quad H_{ideal} \cdot L$$

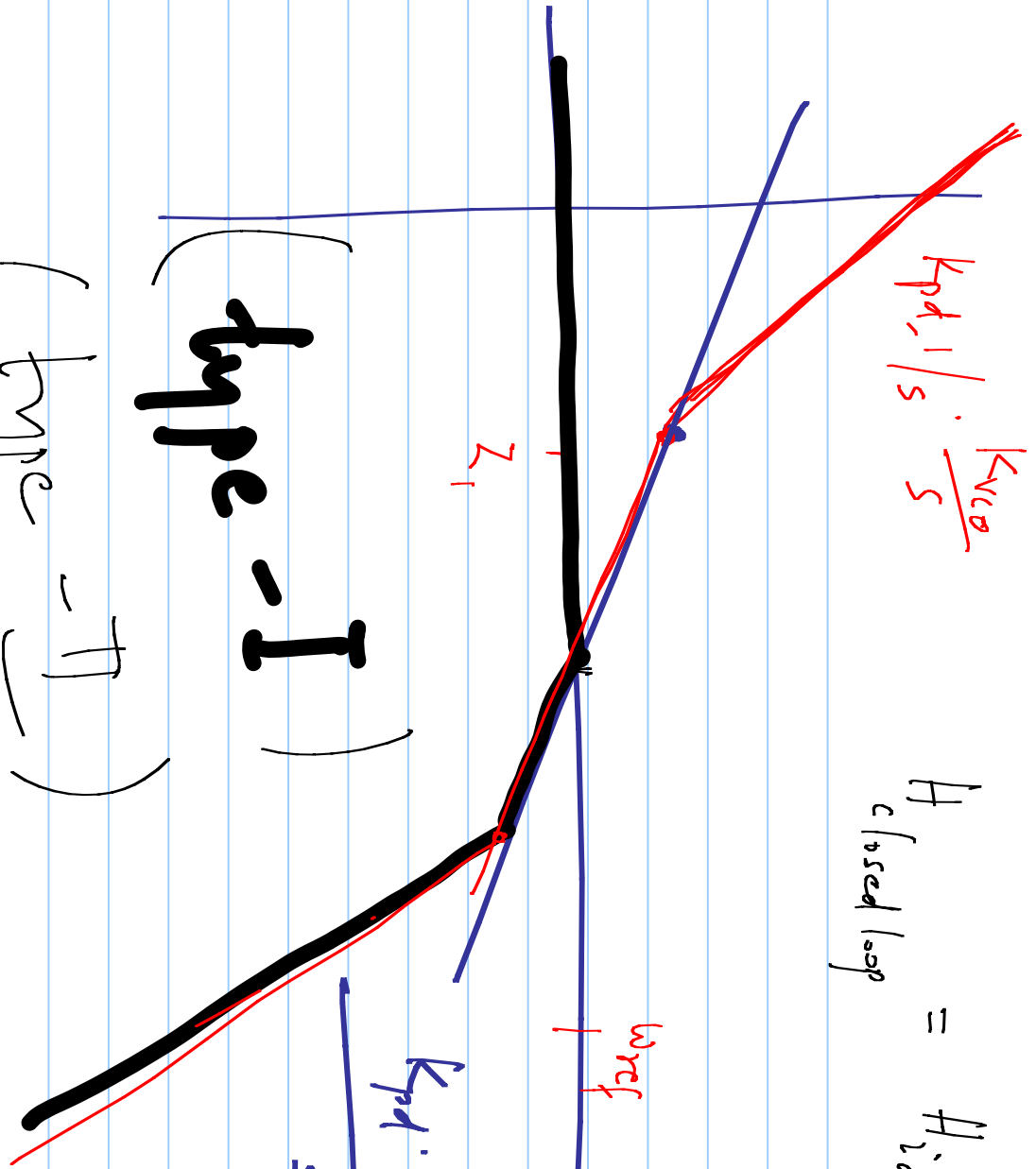
$$K_{pd} \cdot K_{vco}$$

s

z_1

(type - I)

(type - II)



$$\left(\frac{k_{p1,i}}{s} + k_{p1} \right) \cdot \frac{2\pi k_{vco}}{s} \cdot \frac{1}{N}$$

$$\left(\frac{k_{p1,i}}{k_{p1}} \right)$$

$$\frac{k_{p1,i} \cdot k_{vco}}{s} \cdot \frac{1}{N}$$

$$k_{p1} \cdot \frac{k_{vco}}{s} \cdot \frac{1}{N}$$

