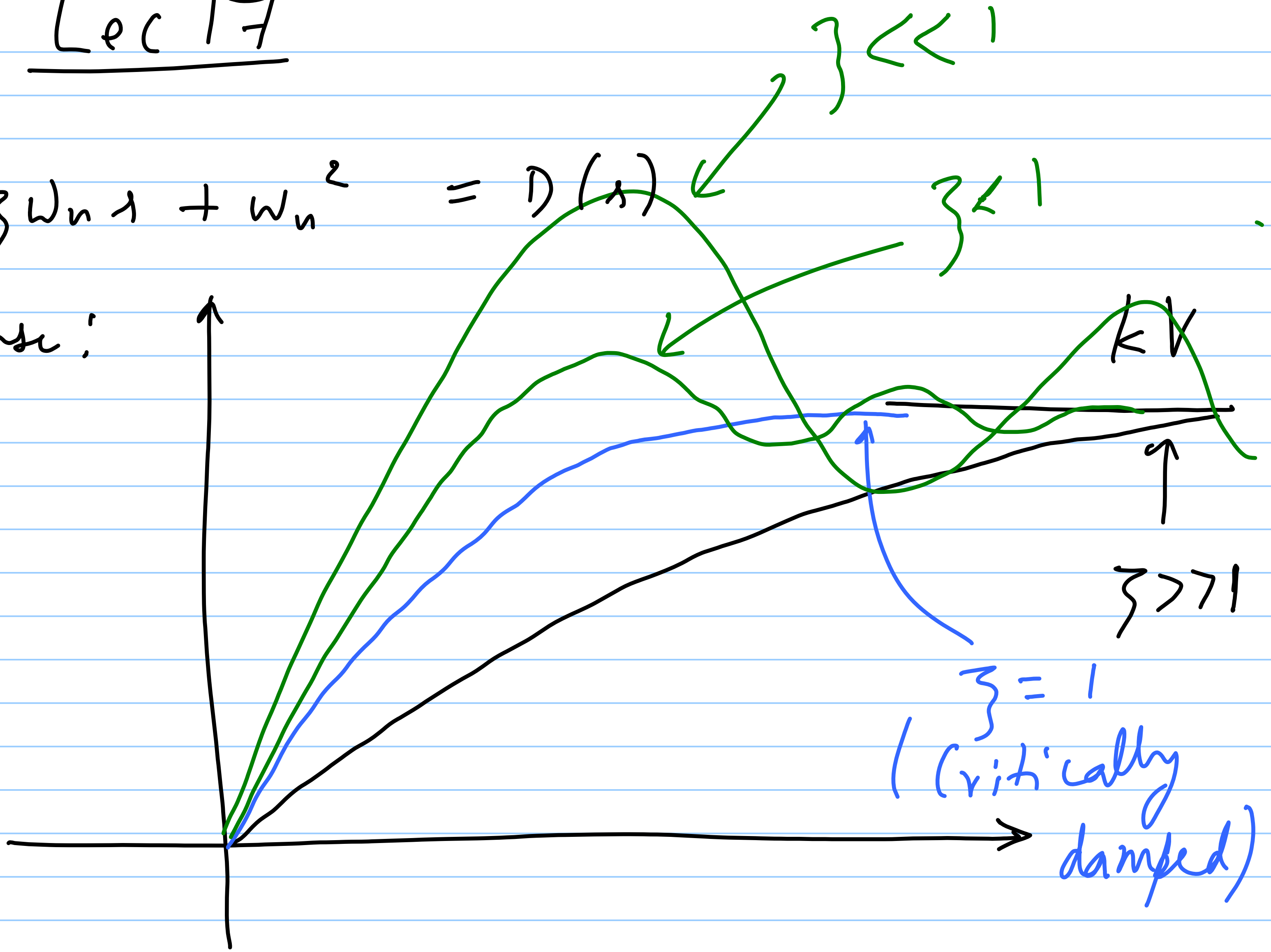
19/2/19

Lec 17

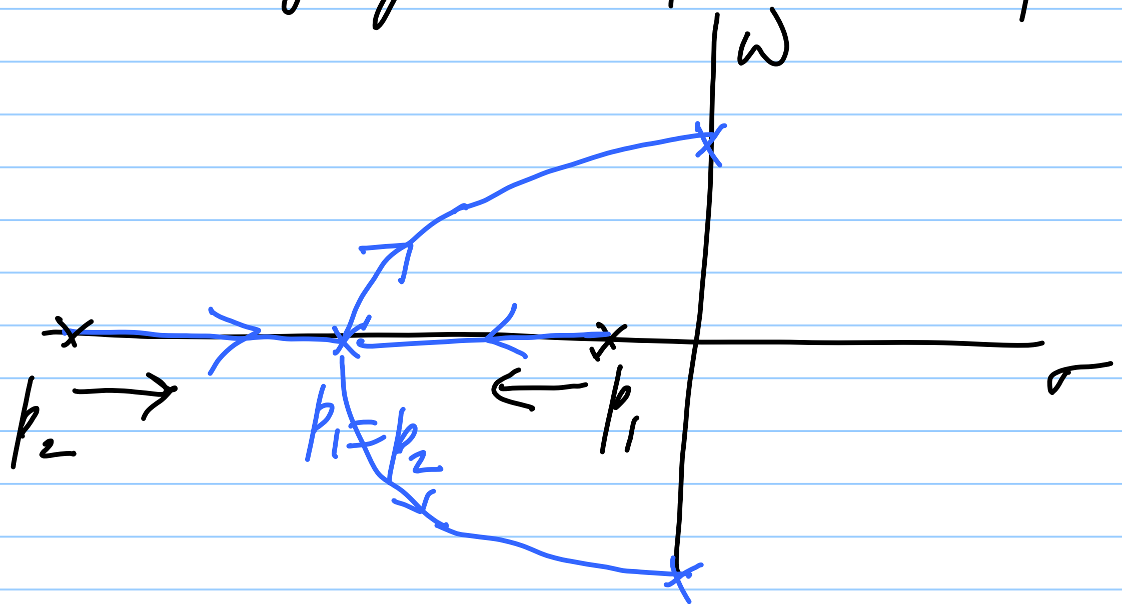
$$s^2 + 2\zeta\omega_n s + \omega_n^2 = D(s)$$

step response:



2nd order system with poles p_1 & p_2

* Unconditionally stable
* Ringing is possible if $\zeta < 1$

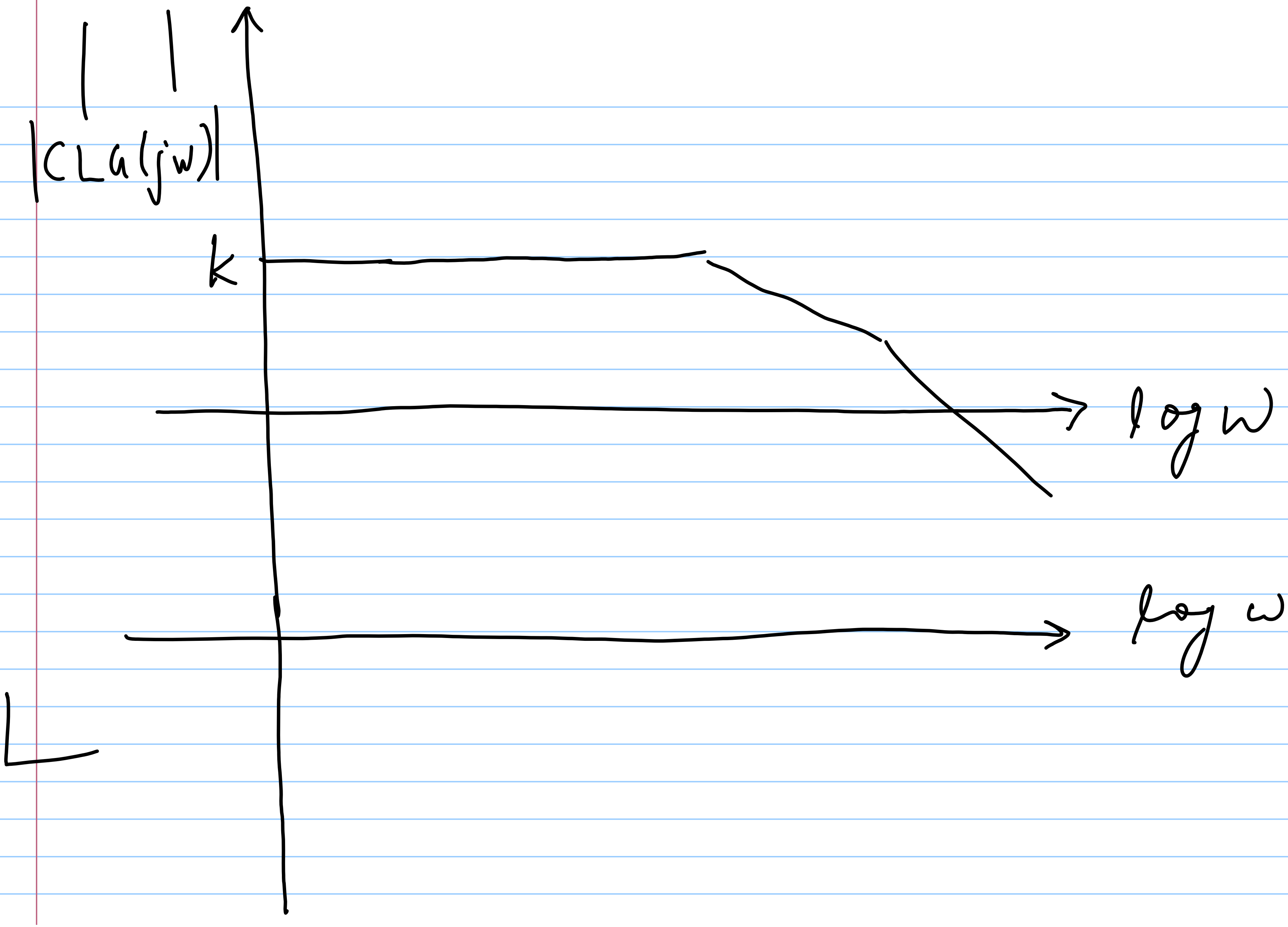


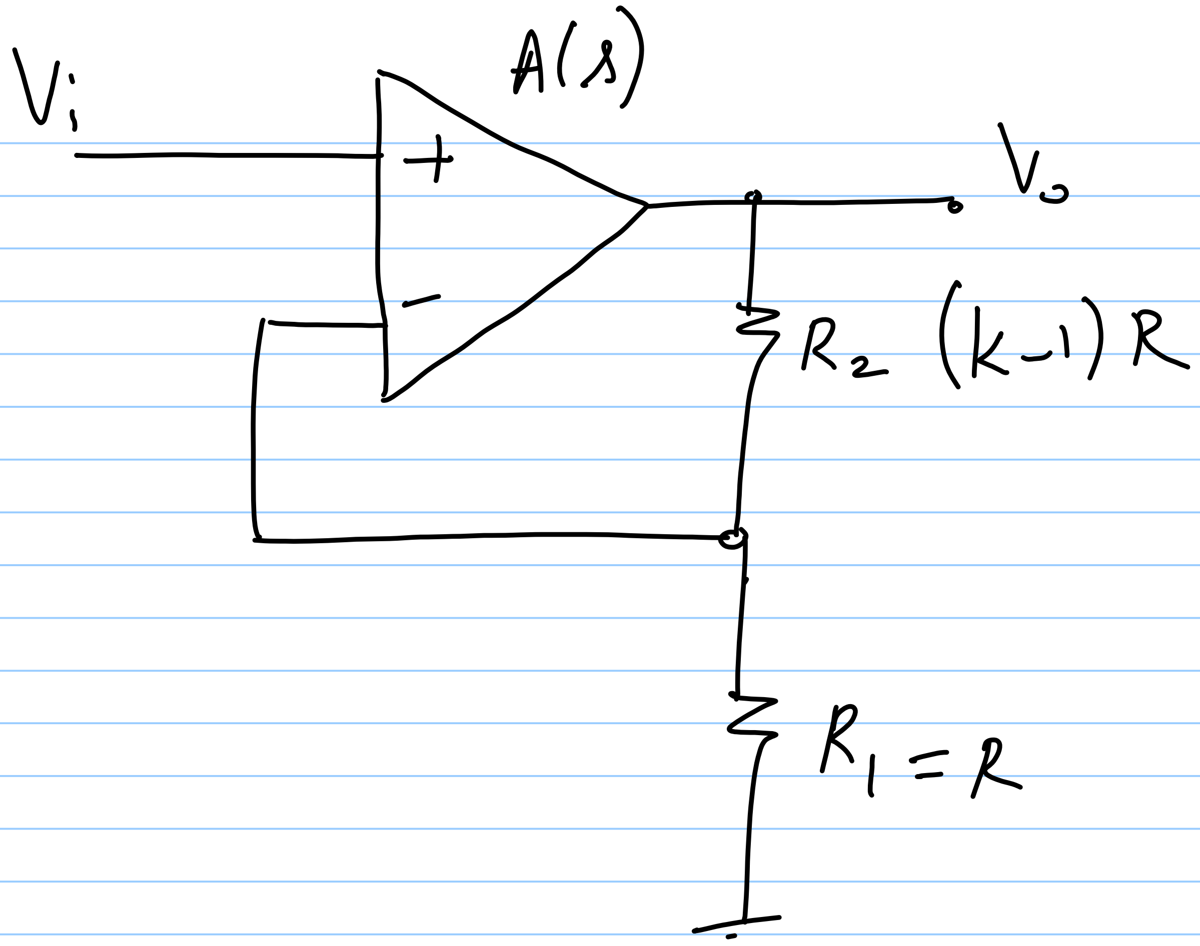
real poles p_1 & p_2

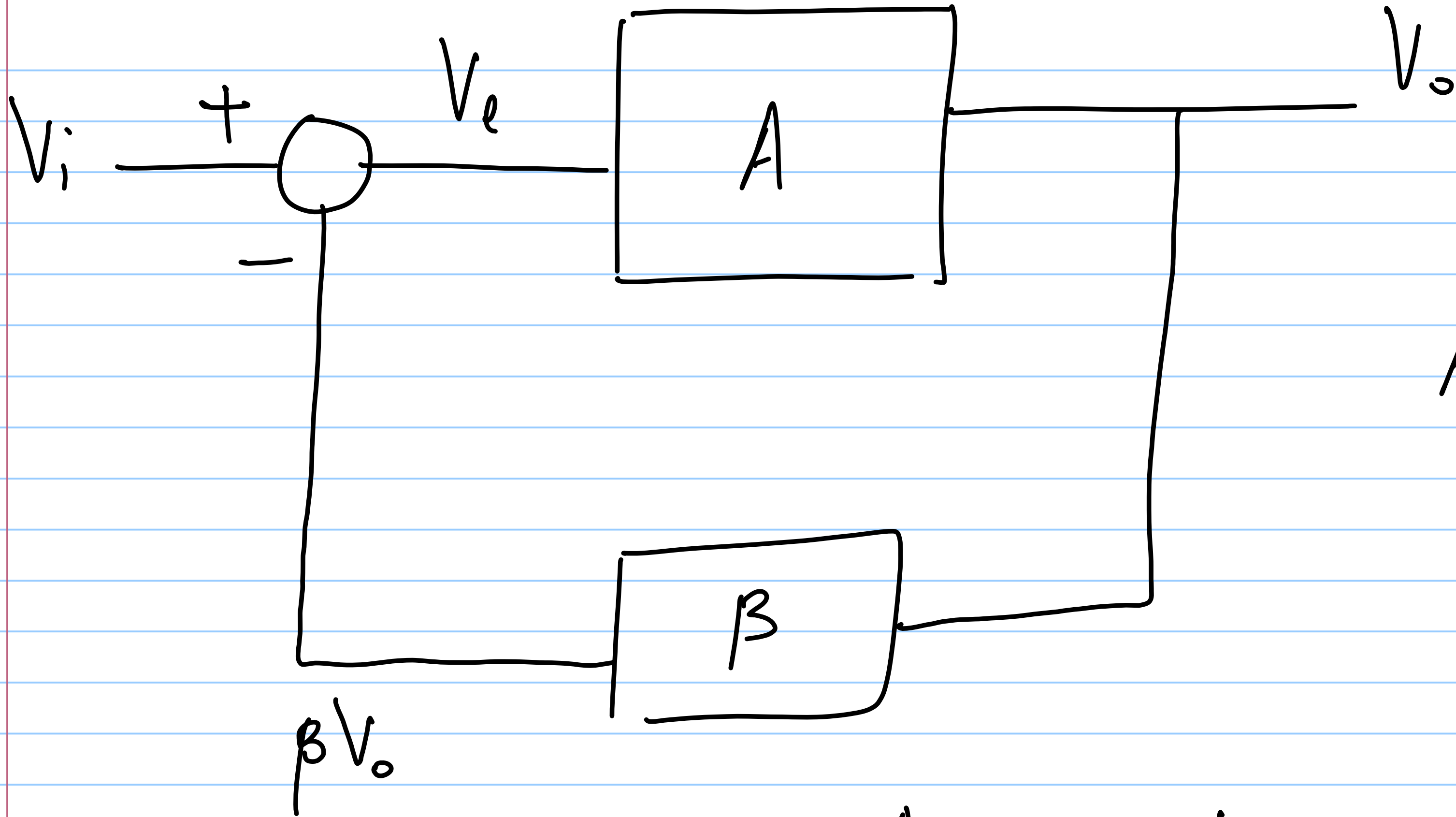
$p_2 >> p_1 \Rightarrow \zeta >> 1$

$\zeta < 1 \Rightarrow$ complex conjugate poles

$\sigma \pm j\omega$


|CLa(jw)|
k
log w
log w
L

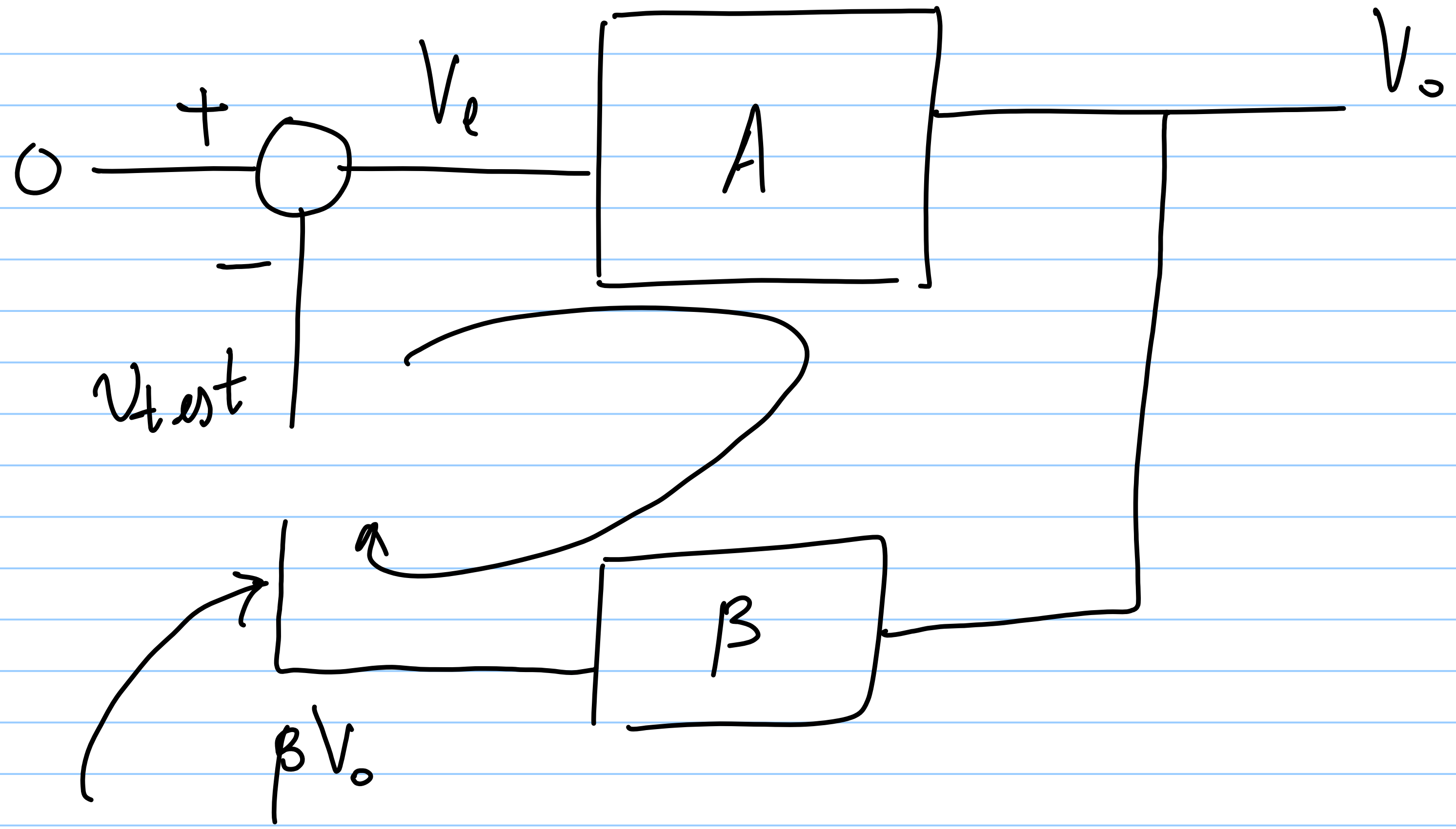

A(s)
V_i
+
−
V_o
R_2 (k−1) R
$R_1 = R$



$A\beta$ = Loop gain

$$CLG = \frac{A}{1+A\beta} = \frac{1}{\beta} \cdot \frac{A\beta}{1+A\beta}$$

$$|A\beta| \gg 1$$



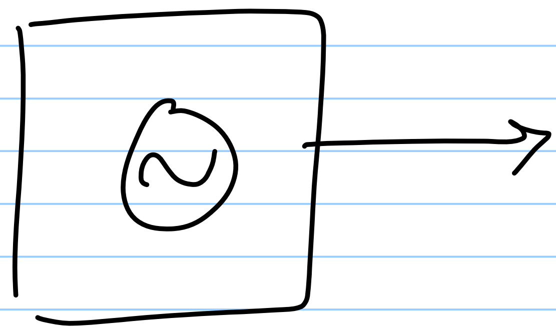
$$\underbrace{-A\beta}_{\text{Loop gain}}\, v_{test}$$

$$CLG = \frac{1}{\beta} \cdot \frac{A\beta}{1+A\beta}$$

$$|A\beta| \gg 1 \Rightarrow CLG \approx \frac{1}{\beta}$$

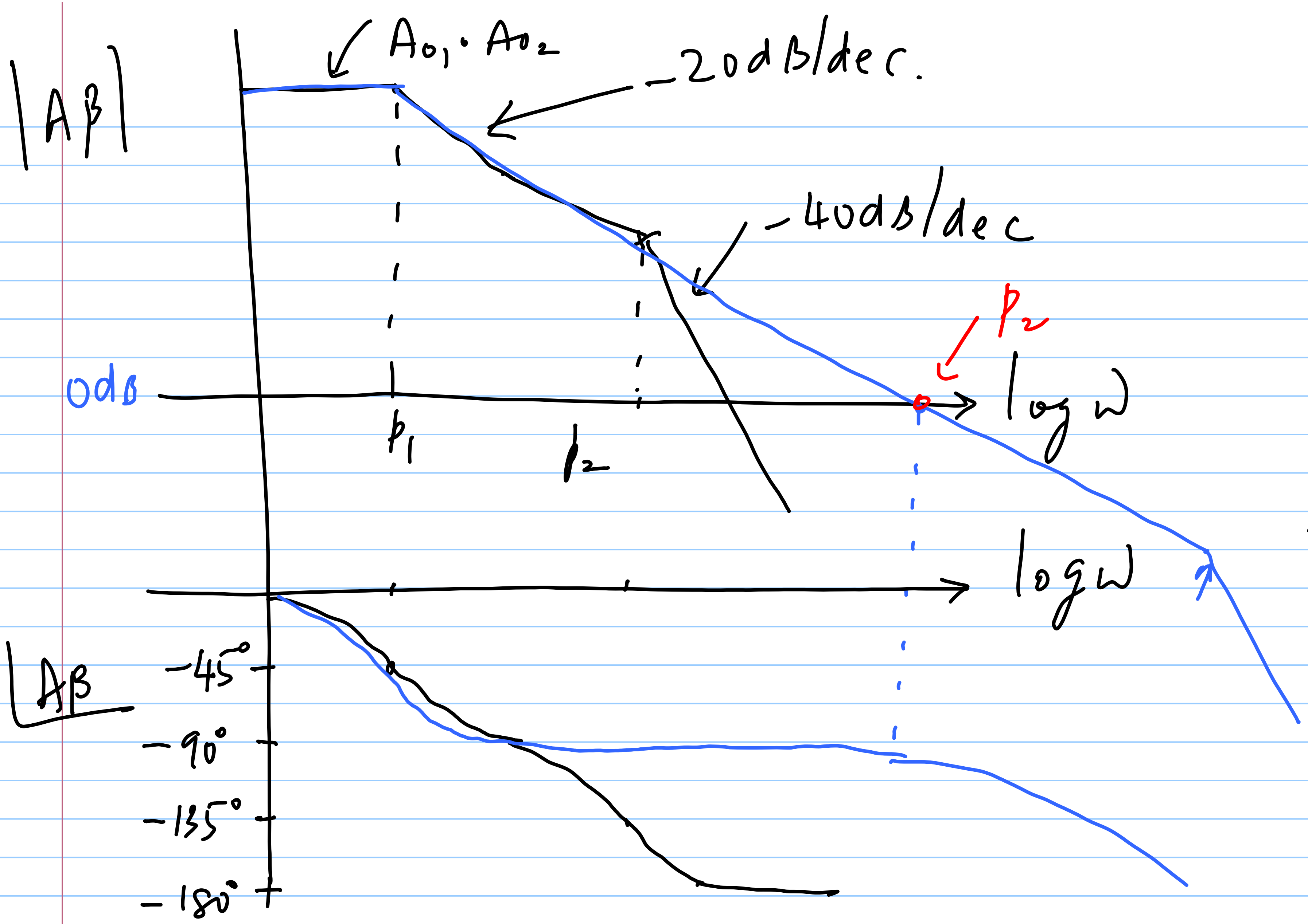
$$|A\beta| = 1 \quad \& \quad \angle A\beta = -180^\circ$$

$$A\beta = -1 \Rightarrow CLG = \infty$$



OSC : no input but finite output

$A\beta = -1$



2-stage opamp

e.g. $p_2 > 10p_1$

Barkhausen Criteria for stability:

$$@ \ |A\beta| = 1 \ : \ \angle A\beta < -180^\circ$$

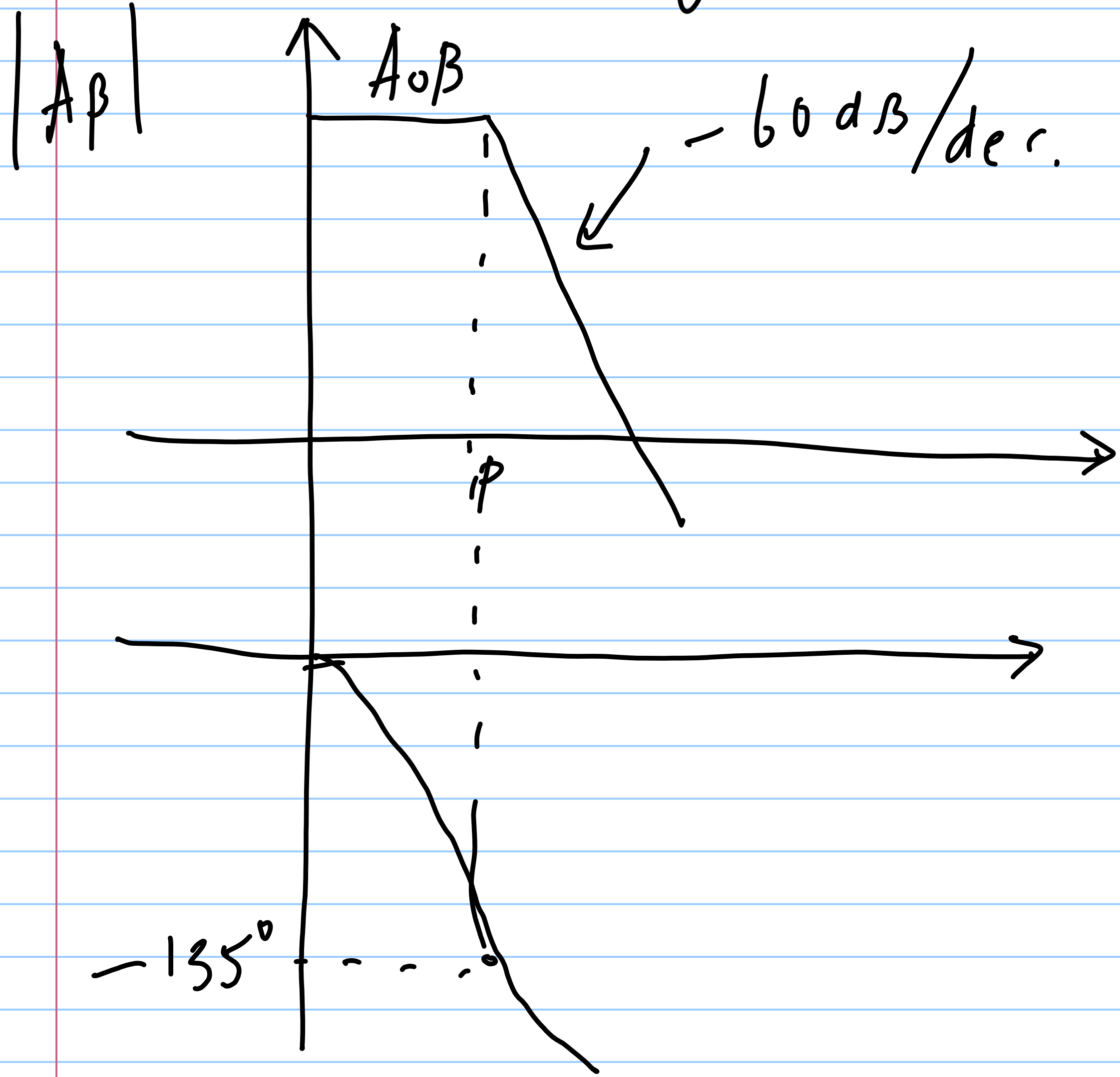
$$@ \ \angle A\beta = -180^\circ : \ |A\beta| << 1$$

(System with no zeroes)

"Phase margin" $= 180^\circ + \angle A\beta$ @ $|A\beta| = 1$ frequency

"Gain margin" $= -|A\beta|_{dB}$ @ $\angle A\beta = -180^\circ$ frequency

3rd order system



$$\frac{A_0}{\left(1+\frac{s}{p_1}\right)\left(1+\frac{s}{p_2}\right)\left(1+\frac{s}{p_3}\right)}$$

e.g. $p_1 = p_2 = p_3$

$$\frac{A_0}{\left(1+\frac{s}{p}\right)^3}\cdot\beta$$