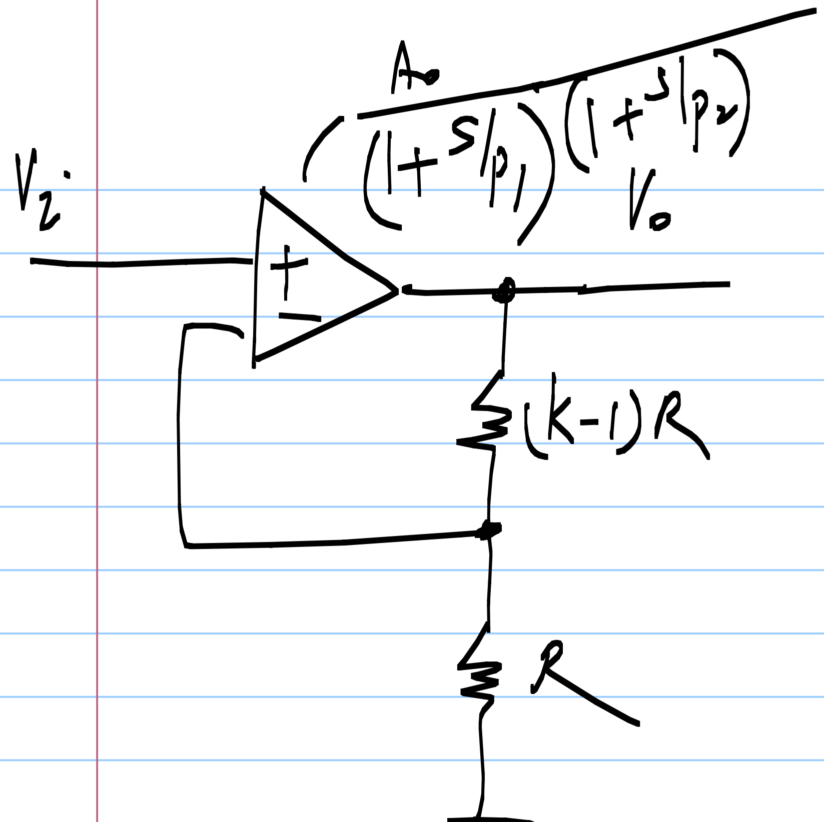
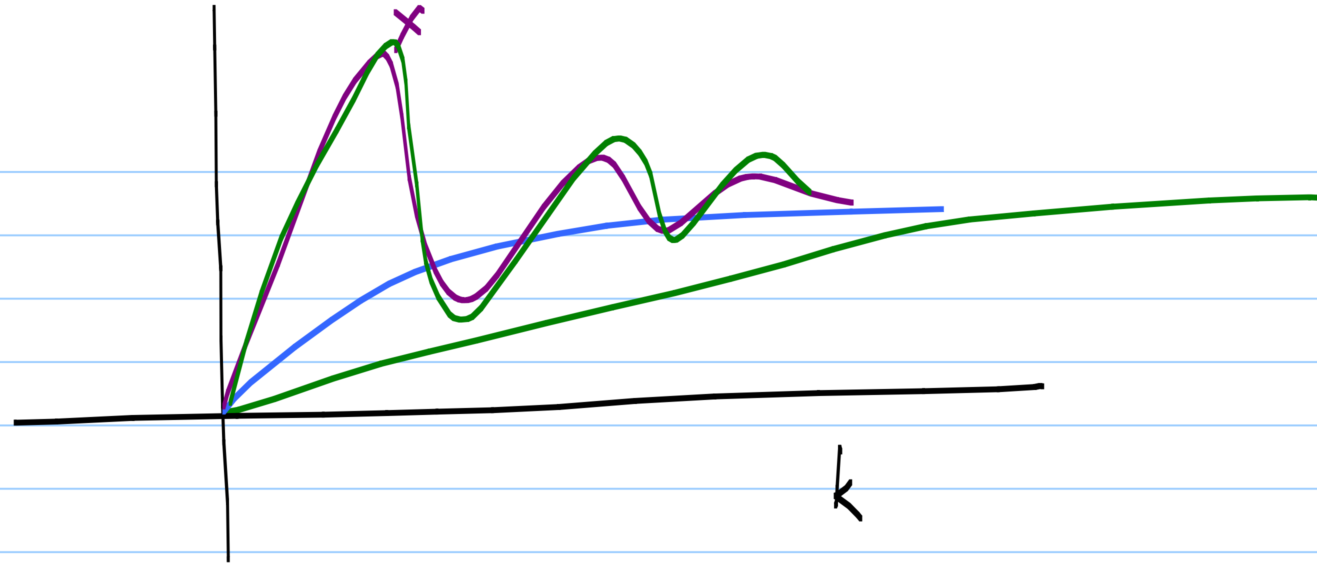


$$\frac{V_o(s)}{V_i(s)} = \frac{k}{1 + \frac{k}{A_0}\cdot\left(1+\frac{s}{p_1}\right)\left(1+\frac{s}{p_2}\right)}$$

$$= \frac{k}{\left(1+\frac{k}{A_0}\right) + \frac{k}{A_0}\left(\frac{s}{p_1}+\frac{s}{p_2}\right) + \frac{k\,s^2}{A_0 p_1 p_2}}$$

$\boxed{\omega_n,\ \zeta}$

$$\frac{G}{1+GH} = \frac{1/H}{\left\{\frac{1}{GH}\right\}+1}$$



$$= \frac{k}{\left(1+\frac{k}{A_0}\right) + \frac{k}{A_0}\left(\frac{s}{p_1}+\frac{s}{p_2}\right) + \frac{k\, s^2}{A_0 p_1 p_2}}$$

$$\omega_n = \sqrt{\left(\frac{A_0}{k}+1\right)\cdot p_1 p_2} \simeq \sqrt{\frac{A_0}{k}\cdot p_1 p_2}$$

$$\xi = \frac{k}{A_0}\cdot\left(\frac{1}{p_1}+\frac{1}{p_2}\right) \Big/ 2\cdot\sqrt{\left(1+\frac{k}{A_0}\right)\cdot\frac{k}{A_0 p_1 p_2}}$$

$$\omega_n = \sqrt{\left(\frac{A_0}{K}+1\right)\cdot p_1 p_2} \simeq \sqrt{\frac{A_0}{K}\cdot p_1 p_2}$$

$$\xi = \frac{K}{A_0}\cdot\left(\frac{1}{p_1}+\frac{1}{p_2}\right) \Big/ 2\cdot\sqrt{\left(1+\frac{K}{A_0}\right)\cdot\frac{K}{A_0 p_1 p_2}}$$

$$p_2 = \frac{A_0}{K}\cdot p_1$$

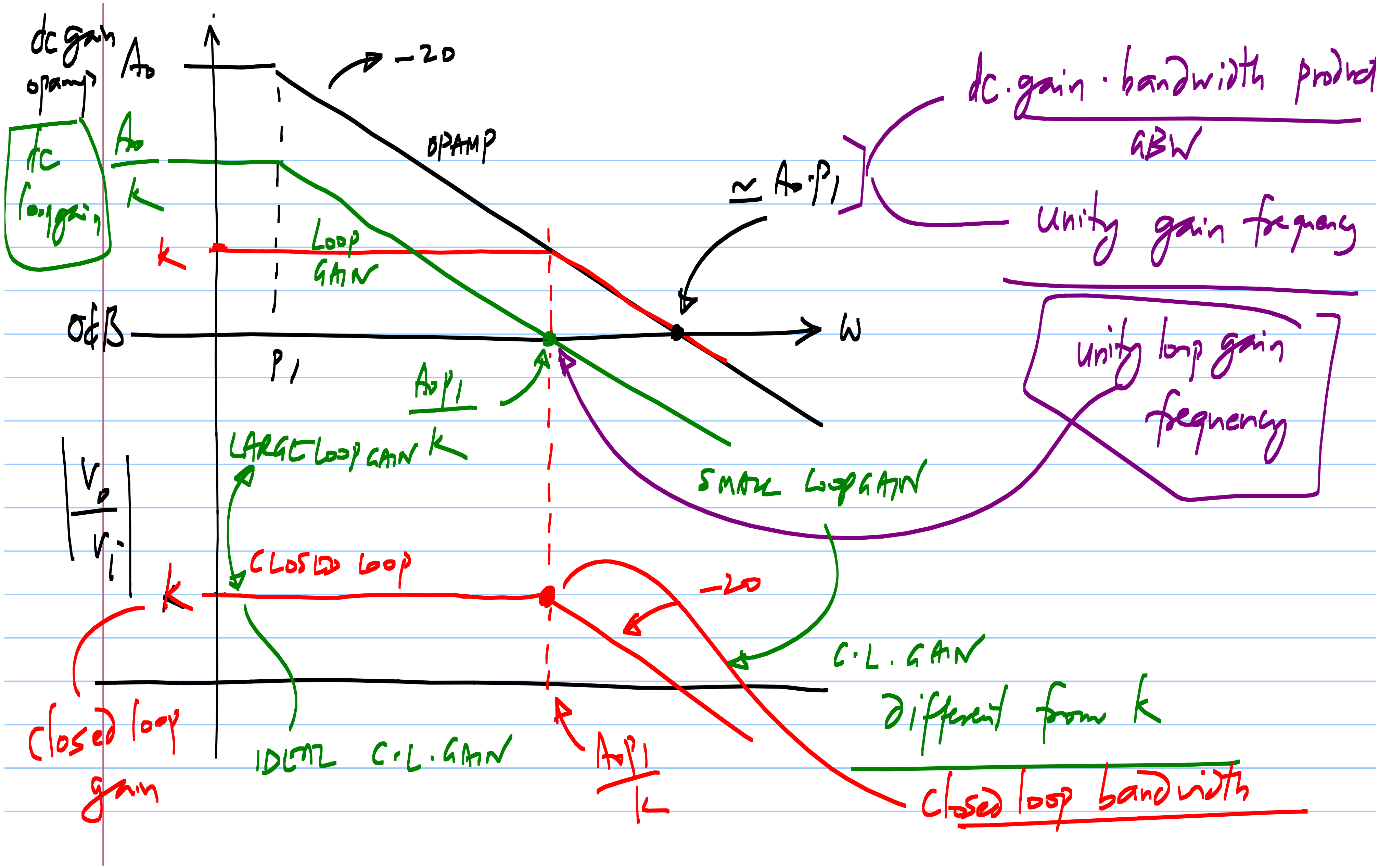
$$= \frac{1}{2\cdot\sqrt{\frac{A_0}{K}+1}}\left(\sqrt{\frac{p_1}{p_2}}+\sqrt{\frac{p_2}{p_1}}\right)$$

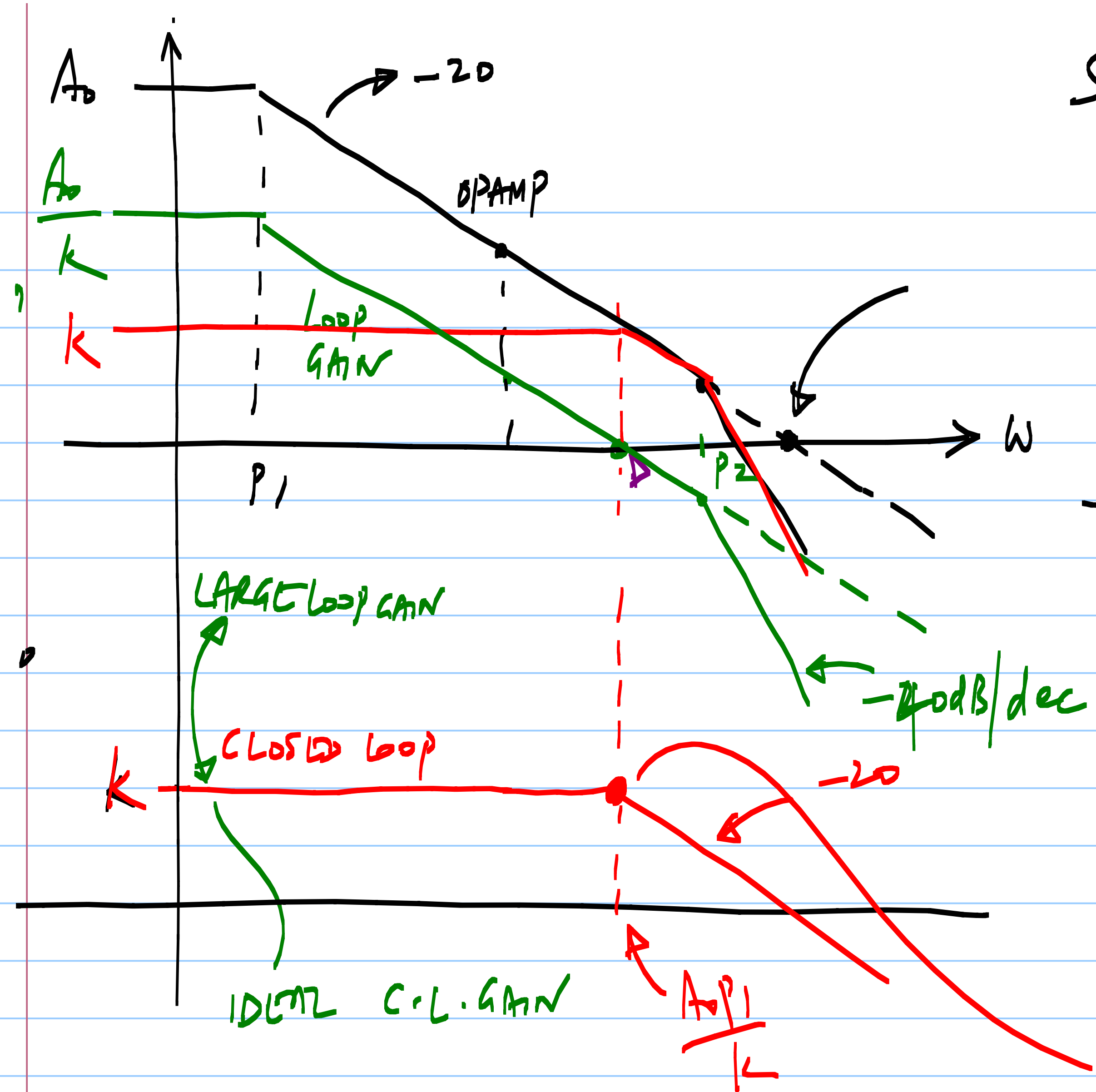
$$\underline{\underline{p_2 > p_1}}$$

$$\times$$

$$\simeq \frac{1}{2\sqrt{\frac{A_0}{K}}}\cdot\sqrt{\frac{p_2}{p_1}} = \frac{1}{2}\cdot\sqrt{\frac{p_2}{\left(\frac{A_0}{K}\cdot p_1\right)}}$$

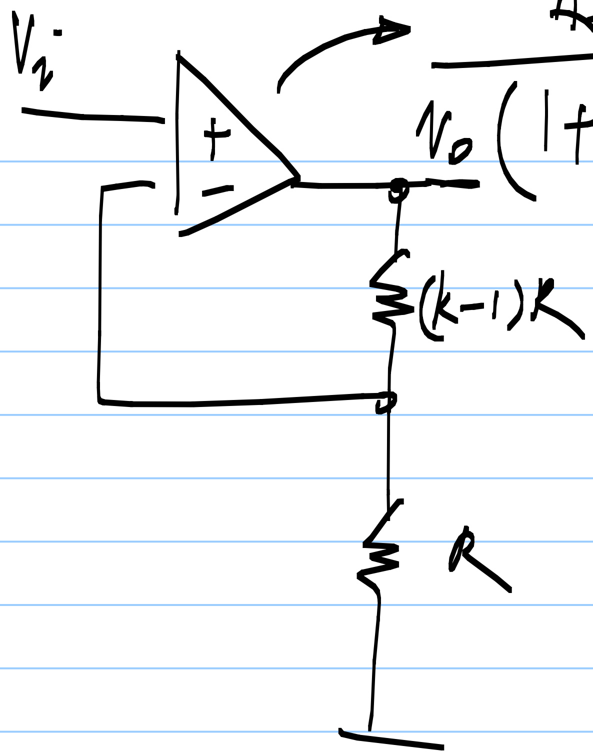
$$\underline{p_2 = 4\cdot\left(\frac{A_0}{K}\cdot p_1\right)}$$


dc gain opamp
A_o
dc loop gain
$\frac{A_o}{k}$
k
0 dB
p_1
-20
OPAMP
LOOP GAIN
$\frac{A_o p_1}{k}$
$\simeq A_o \cdot p_1$
ω
dc·gain·bandwidth product
GBW
unity gain frequency
unity loop gain frequency
LARGE LOOP GAIN k
SMALL LOOP GAIN
$\left|\frac{v_o}{v_i}\right|$
k
CLOSED LOOP
-20
C.L. GAIN
different from k
closed loop gain
IDEAL C.L. GAIN
$\frac{A_o p_1}{k}$
closed loop bandwidth



Second order system well behaved if p_2 is beyond the unity loop gain frequency

Effectively "looks like" a first order system



$$\frac{A_o}{\left(1+s/p_1\right)^3}$$

$$\frac{V_o}{V_i} = \frac{k}{1+\frac{k}{A_o}\left(1+\frac{s}{p_1}\right)^3}$$

For some $s = j\omega_o$ $\quad \frac{V_o}{V_i} = \infty$

$= 0$ for $s = j\omega_o$