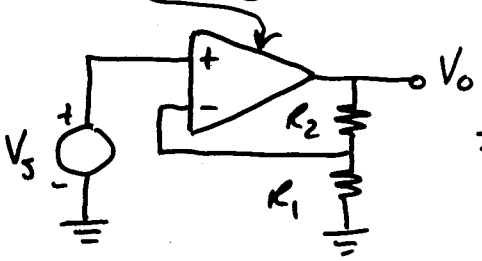
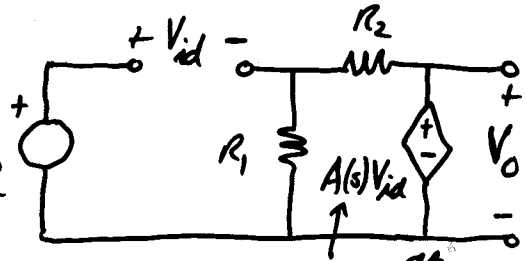
Frequency Response of the Non-Inverting Amplifer

$A(s) = \dfrac{A_0}{\frac{s}{\omega_B}+1}$ ← Op amp differential voltage gain

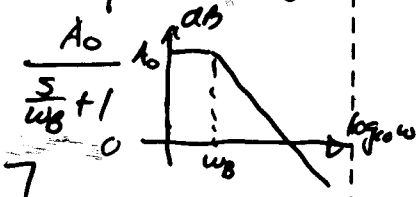
← $A_0 \neq \infty$ & $\omega_B \neq 0$



$\Rightarrow$



Ideally $\dfrac{V_0}{V_s} = \dfrac{R_1+R_2}{R_1}$



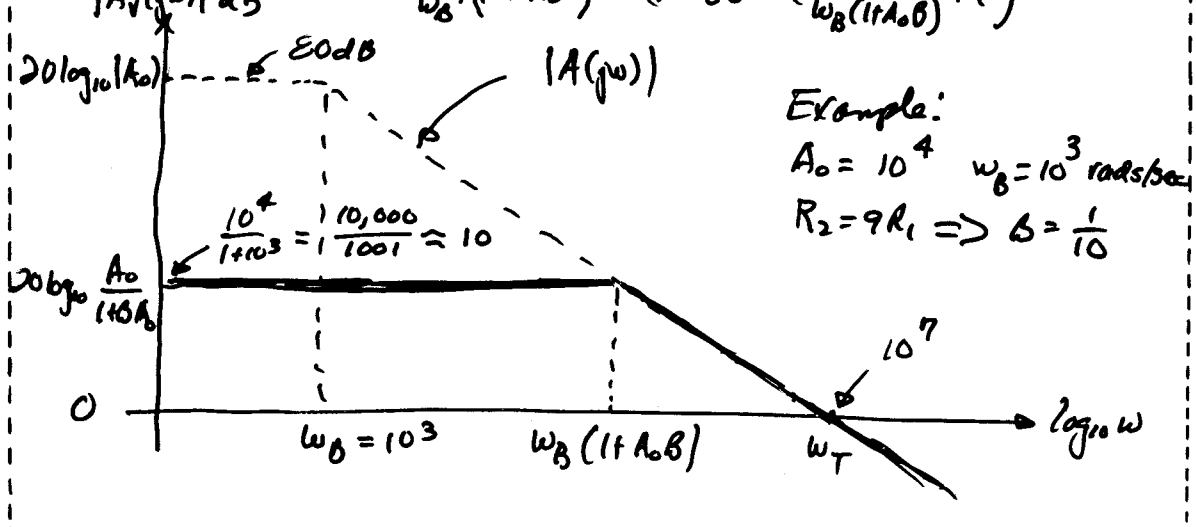
$$V_0(s) = A_V(s)V_{id} = A_V(s)\left[V_s - \frac{R_1}{R_1+R_2}V_0\right]$$

$$V_0\left[1 + A_V(s)\frac{R_1}{R_1+R_2}\right] = A_V(s)V_s \longrightarrow \frac{V_0(s)}{V_s(s)} = \frac{A_V(s)}{1+A_V(s)\frac{R_1}{R_1+R_2}}$$

$$A_V(s) = \frac{V_0(s)}{V_s(s)} = \frac{1}{\frac{1}{A_V(s)} + \frac{R_1}{R_1+R_2}} = \frac{1}{\frac{\frac{s}{\omega_B}+1}{A_0} + \frac{R_1}{R_1+R_2}} = \frac{A_0}{\frac{s}{\omega_B}+1+\frac{A_0R_1}{R_1+R_2}}$$

Let $\beta \equiv \dfrac{R_1}{R_1+R_2}$ (feedback factor)

$$A_V(s) = \frac{A_0}{\frac{s}{\omega_B}+(1+A_0\beta)} = \left(\frac{A_0}{1+A_0\beta}\right)\left(\frac{1}{\frac{s}{\omega_B(1+A_0\beta)}+1}\right)$$

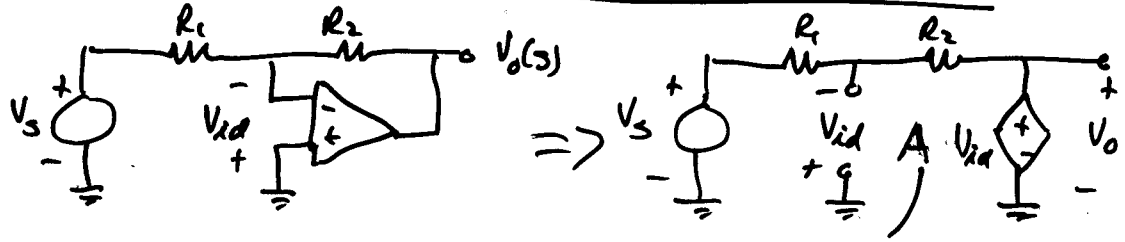


Example:

$A_0 = 10^4$ $\omega_B = 10^3$ rads/sec

$R_2 = 9R_1 \Rightarrow \beta = \frac{1}{10}$

INVERTING AMPLIFIER FREQUENCY RESPONSE



$$\frac{A_0}{\frac{s}{\omega_B}+1}$$

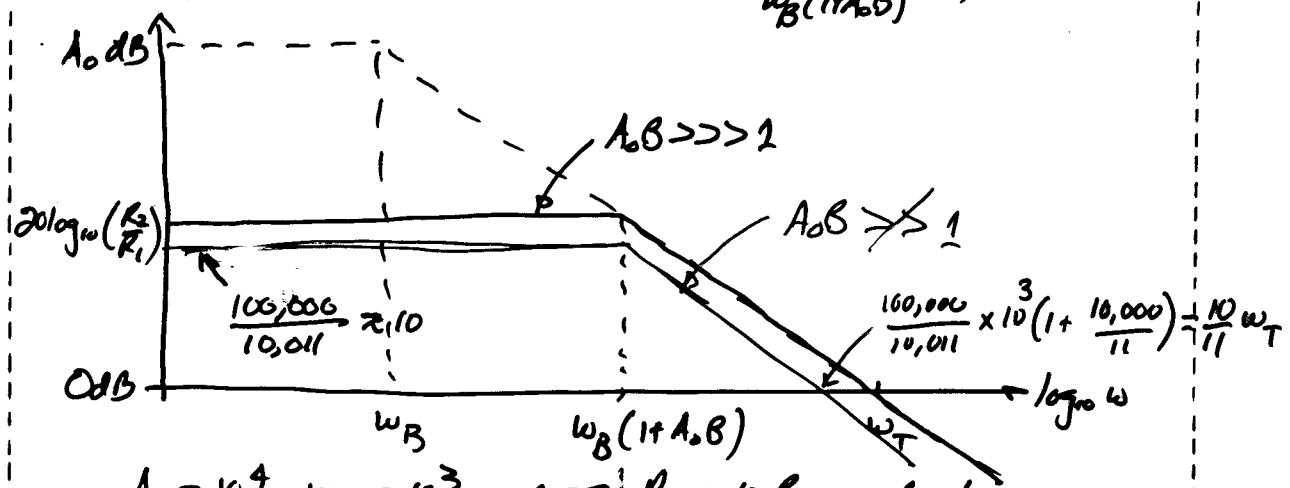
$$V_o = A V_{id} = -A\left[\frac{R_2}{R_1+R_2} V_s + \underbrace{\frac{R_1}{R_1+R_2}}_{B} V_o\right] = -\frac{A R_2}{R_1+R_2} V_s - AB V_o$$

$$V_o(1+AB) = -\frac{R_2}{R_1} AB V_s \quad \longrightarrow \quad \frac{V_o}{V_s} = \left(-\frac{R_2}{R_1}\right)\frac{AB}{1+AB}$$

$$\frac{V_o(s)}{V_s(s)} = A_V(s) = -\left(\frac{R_2}{R_1}\right)\frac{B}{\frac{1}{A}+B}$$

Finally,

$$|A_V(j\omega)|_{dB} \quad A_V(s) = \left(-\frac{R_2}{R_1}\right)\left(\frac{A_0 B}{1+A_0 B}\right)\left(\frac{1}{\frac{s}{\omega_B(1+A_0B)}+1}\right)$$



$A_0 = 10^4$, $\omega_B = 10^3$, ~~$R_2 = 10 R_1$~~ $\rightarrow B = \frac{1}{11}$

$$\frac{A_0 B}{1+A_0 B} = \frac{10^4/11}{1+10^4/11} = \frac{10^4}{11+10^4} = \frac{10,000}{10,011}$$