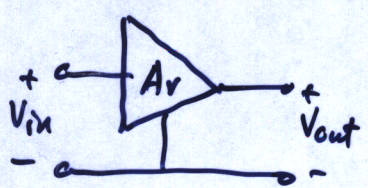


Bode Plots and Frequency Response

First-Order, High-Pass Amplifier

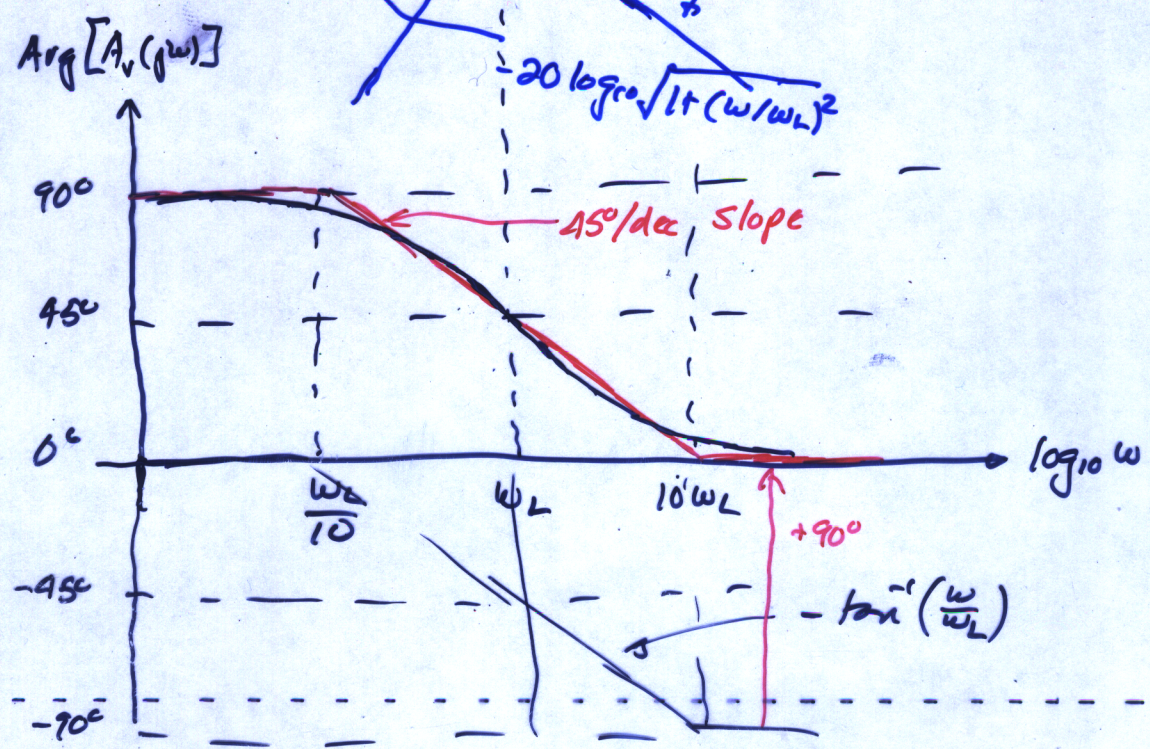
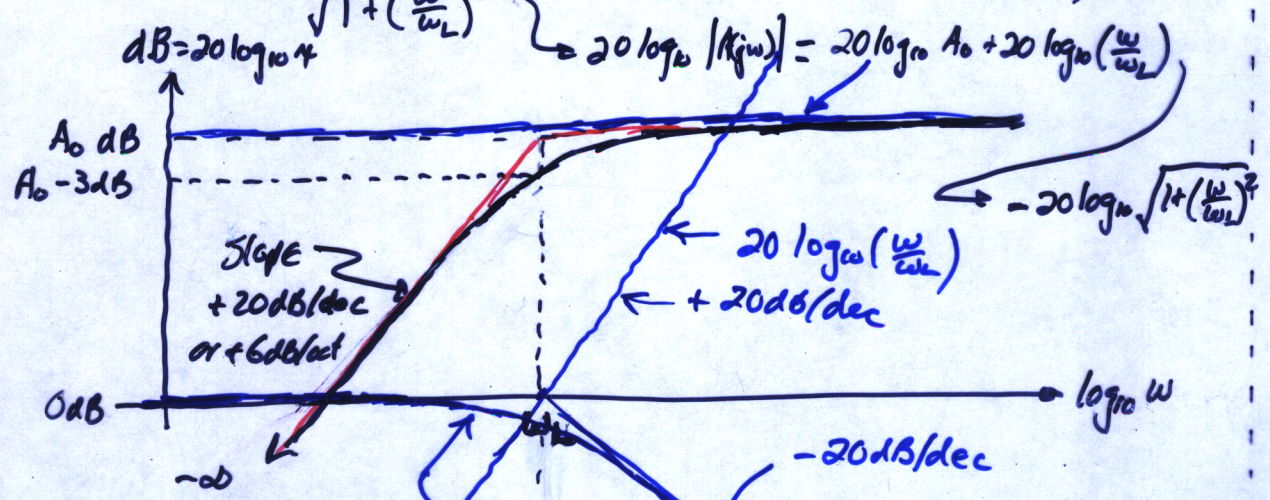


$$A_v(s) = \frac{V_{out}(s)}{V_{in}(s)} = \frac{A_0 s}{s + \omega_L}$$

$$s \rightarrow j\omega \therefore A(j\omega) = \frac{A_0 j\omega}{j\omega + \omega_L} = \frac{A_0 \frac{j\omega}{\omega_L}}{1 + \frac{j\omega}{\omega_L}}$$

$$|A(j\omega)| = \frac{A_0 \frac{\omega}{\omega_L}}{\sqrt{1 + \left(\frac{\omega}{\omega_L}\right)^2}}$$

$$\text{Arg}[A(j\omega)] = 90^\circ - \tan^{-1}\left(\frac{\omega}{\omega_L}\right)$$

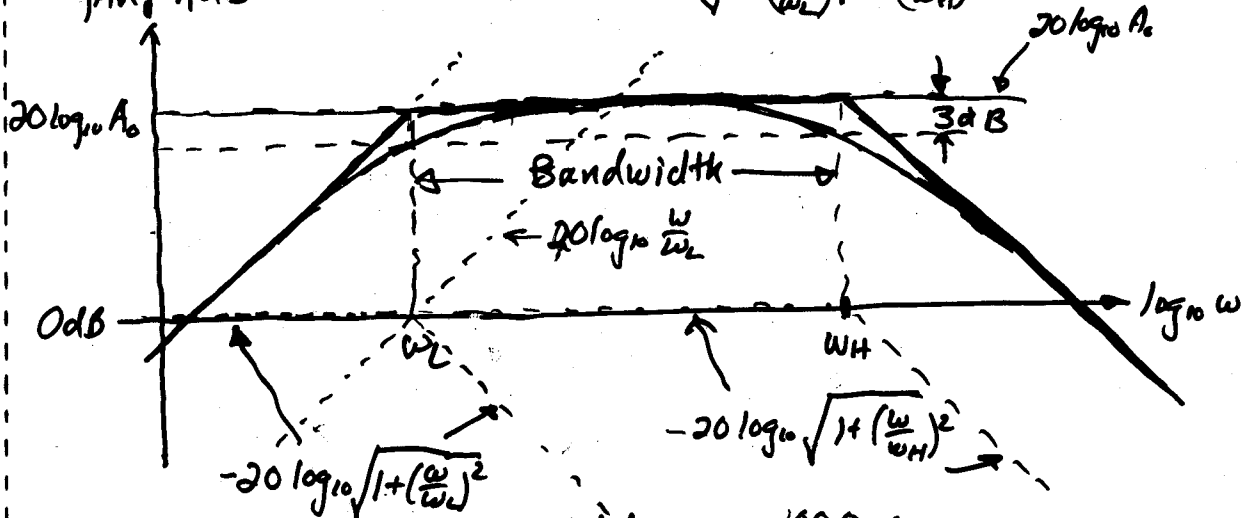


Bandpass Amplifier

$$A_v(s) = \left( \frac{A_0 s}{(s + \omega_L)} \right) \left( \frac{\omega_H}{s + \omega_H} \right) = \frac{A_0 s \omega_H}{(s + \omega_L)(s + \omega_H)}$$

$\omega_H \gg \omega_L$

$$|A_v(j\omega)| = \frac{A_0 \omega \omega_H}{\sqrt{\omega^2 + \omega_L^2} \sqrt{\omega^2 + \omega_H^2}} = \frac{A_0 \frac{\omega}{\omega_L}}{\sqrt{1 + \left(\frac{\omega}{\omega_L}\right)^2} \sqrt{1 + \left(\frac{\omega}{\omega_H}\right)^2}}$$



Practice Bode Plots! !!

$$\frac{1000 s}{(s+1)(s+100)} = \frac{10^3 (s)}{(s+1)(s+10^2)}$$

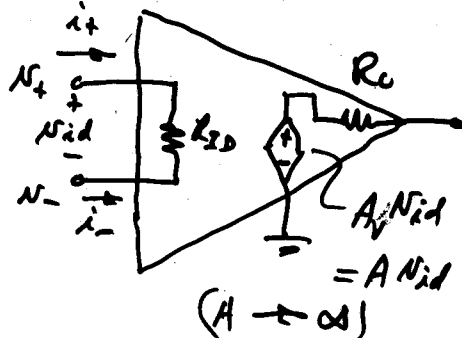
OP AMPS (operational amplifiers)

Def.- An op amp is a high gain amplifier intended to be used with negative feedback to define the transfer function.

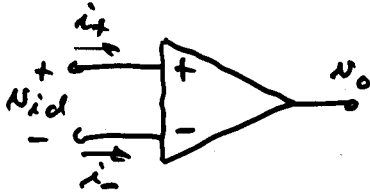
Characteristics of an op amp:



2.)  $A_v = A \rightarrow \infty$



Ideal Op Amp



An ideal op amp has

$v_{id} = 0$

and

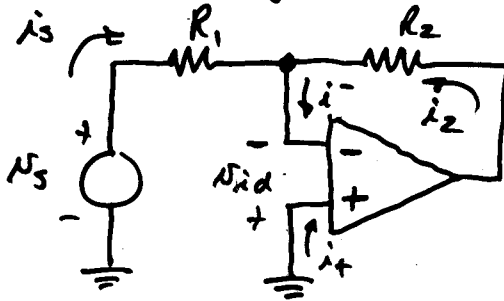
$i_+ = i_- = 0$

All this happens because of 2 reasons,

1.)  $A_v \rightarrow \infty$

2.) There is some form of -fb. from output back to input.

Inverting Voltage Amplifier



$v_o = -\frac{R_2}{R_1} v_s$

$\sum i \rightarrow i_1 + i_2 = i_- = 0$

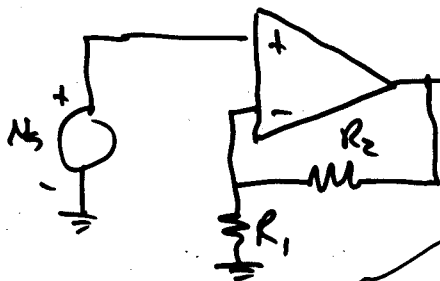
$\therefore i_1 = -i_2$

But,  $i_1 = \frac{v_s + v_{id}}{R_1} = \frac{v_s}{R_1}$

$i_2 = \frac{v_o + v_{id}}{R_2} = \frac{v_o}{R_2}$

$\therefore \frac{v_s}{R_1} = -\frac{v_o}{R_2} \Rightarrow \boxed{v_o = -\frac{R_2}{R_1} v_s}$

Noninverting Voltage Amp.



$v_o = \left(\frac{R_1 + R_2}{R_1}\right) v_s$

$R_{ix} = \frac{R_1 R_3 R_5}{R_2 R_4}$

