Quiz Solution on web site (Great average 9.1/10)

Quiz 2 on Friday, Sept. 3, 2004

I. Bandpass frequency response
II. Intro to op amps
III. Op amp circuits

I. Bandpass Frequency Response

$$A_v(s) = \frac{A_0 s \omega_H}{(s+\omega_L)(s+\omega_H)} \qquad \omega_H >> \omega_L$$

$$\lim_{s\to 0} A_v(s) = 0 \qquad \lim_{s\to\infty} A_v(s) = 0$$

$$s = j\omega \rightarrow A_v(j\omega) = \frac{A_0 j\omega \omega_H}{(j\omega+\omega_L)(j\omega+\omega_H)}$$

$(1+j\kappa)$

$$A_v(j\omega) = \frac{A_0 j\frac{\omega}{\omega_L}}{(1+j\frac{\omega}{\omega_L})(1+j\frac{\omega}{\omega_H})}$$

Make a Bode plot (asymptotic plot) of $|A_v(j\omega)|$ and $\text{Arg}[A_v(j\omega)]$.

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

$$\text{Arg}[A_v(j\omega)] = (\pm 180^\circ) + \tan^{-1}(\infty) - \tan^{-1}(\tfrac{\omega}{\omega_L}) - \tan^{-1}(\tfrac{\omega}{\omega_H})$$

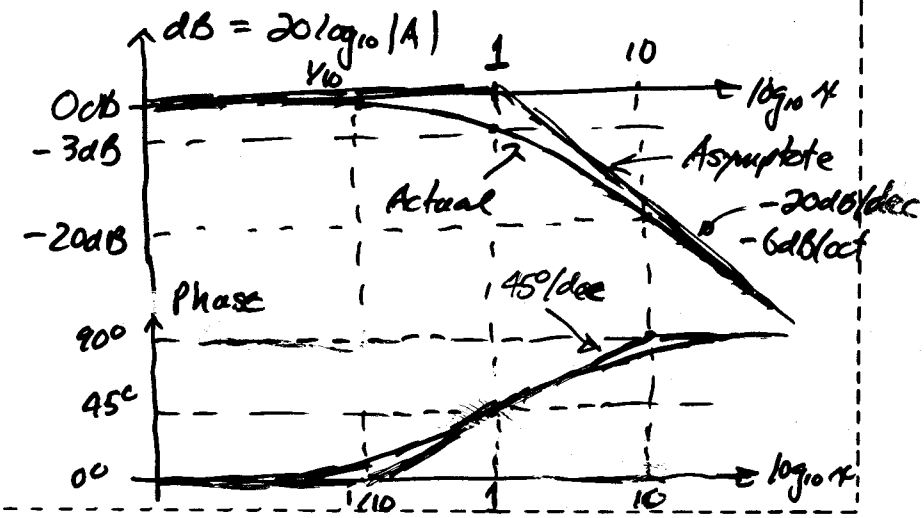
↑ Mixes preceding the transfer funct.

Aside:

$$|A| = \frac{1}{\sqrt{1+\kappa^2}}$$

$$\kappa = \frac{\omega}{\omega_L}$$

$$+\tan^{-1}(\kappa)$$



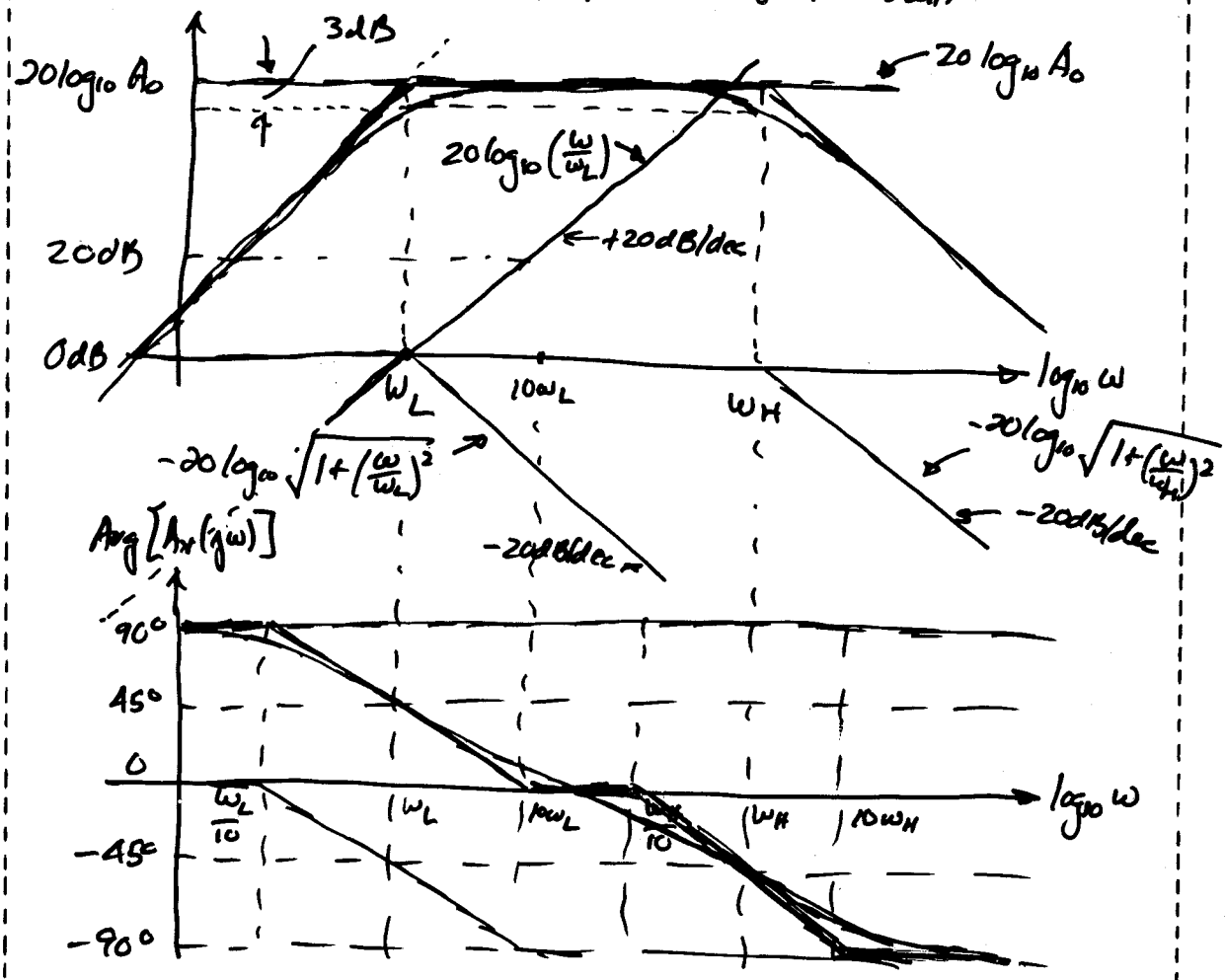
Continuing -

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

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

$$20\log_{10}|A_v(j\omega)| = \pm\cancel{180^\circ} + 20\log_{10}(A_0) + 20\log_{10}\left(\frac{\omega}{\omega_L}\right)$$

$$|A_v(j\omega)|_{dB} = -20\log_{10}\sqrt{1+\left(\frac{\omega}{\omega_L}\right)^2} - 20\log_{10}\sqrt{1+\left(\frac{\omega}{\omega_H}\right)^2}$$

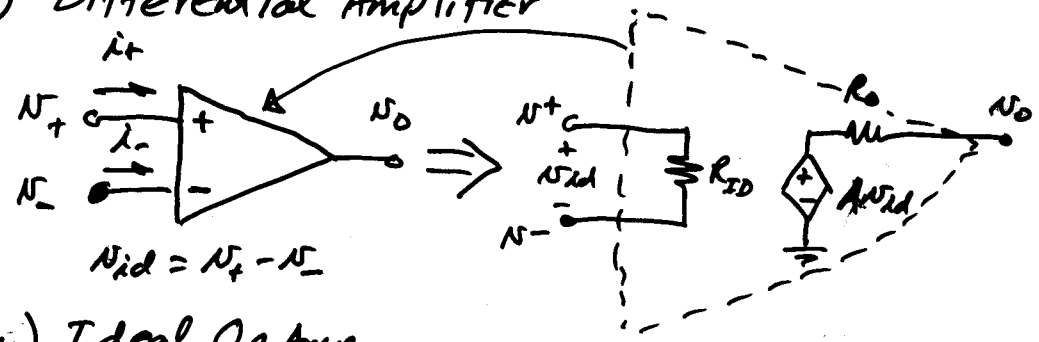


$$\text{Arg}[A_v(j\omega)] = \pm\cancel{180^\circ} + 90^\circ - \tan^{-1}\left(\frac{\omega}{\omega_L}\right) - \tan^{-1}\left(\frac{\omega}{\omega_H}\right)$$

Work as many Bode plot probs as you can.

II. Op Amps

1.) Differential Amplifier



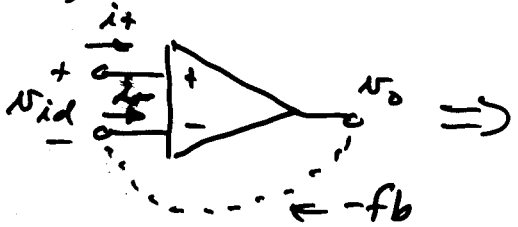
$v_{id} = v_+ - v_-$

2.) Ideal Op Amp

Requirements –

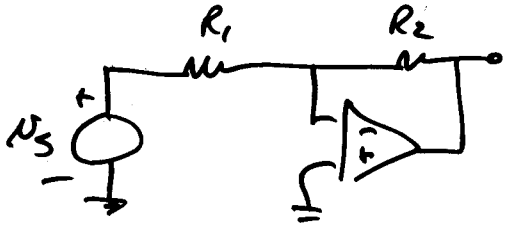
a.) $A \to \infty$ ← KEY

b.) $i_+ = i_- = 0$



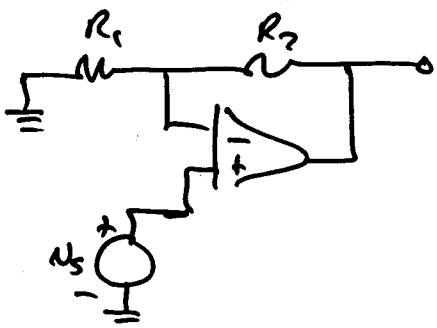
If $A \to \infty$ and if there is some form of negative feedback, then $v_{id} \approx 0$ and $i_+ = i_- \approx 0$

3.) Inverting Amplifier



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

4.) Noninverting Amp.



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