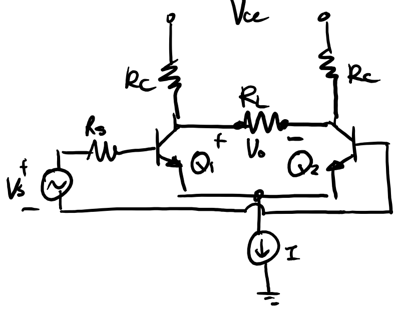
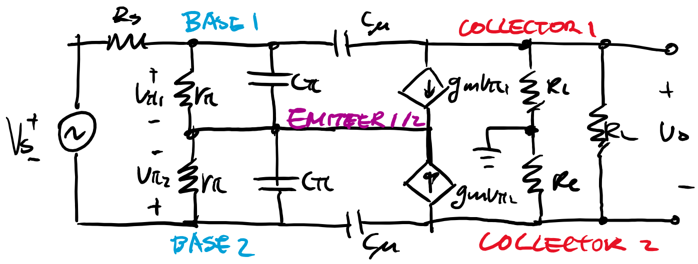
Differential Amplifier Frequency Response

October 30, 2017 4:00 PM

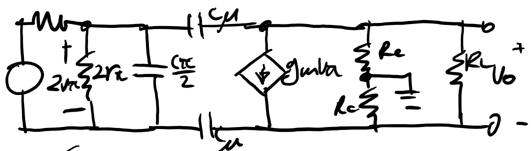
Small Signal Model for the D.A.:





Miller gain: $k = \frac{V_o}{2V_\pi} = -g_m R_c \left(\frac{R_L}{R_L+2R_c}\right)$

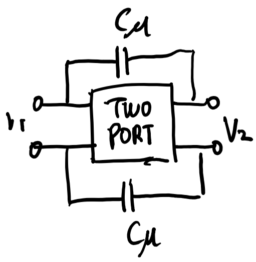
So using miller to separate the capacitors, we get



$C_{\mu 1} = C_\mu \cdot \frac{1}{2}(1-k)$

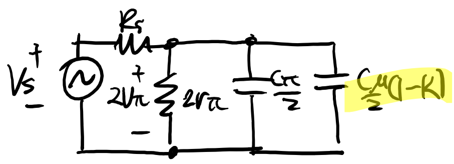
$C_{\mu 2} = C_\mu \cdot \frac{1}{2}\left(1-\frac{1}{k}\right)$

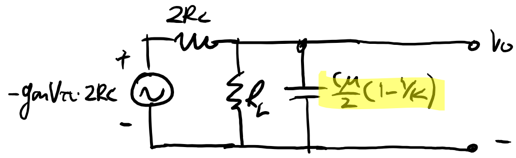
Miller



$Z_1 = \frac{1}{s\frac{C_\mu}{2}(1-k)} \rightarrow C_{\mu 1} = \frac{C_\mu}{2}(1-k)$

$Z_2 = \frac{1}{s\frac{C_\mu}{2}\left(1-\frac{1}{k}\right)} \rightarrow C_{\mu 2} = \frac{C_\mu}{2}\left(1-\frac{1}{k}\right)$





This becomes very similar to the Common Emitter amplifier except there is a factor of 2 to watch out for.

At Midband: $V_o = -g_m V_\pi \cdot 2R_c \cdot \frac{R_L}{R_L+2R_c}$, $2V_\pi = V_s \cdot \frac{2r_\pi}{2r_\pi+R_s}$

$\rightarrow V_o = -g_m V_s \cdot \frac{2r_\pi}{2r_\pi+R_s} R_c \frac{R_L}{R_L+2R_c}$

$$\boxed{A_M = \frac{V_o}{V_s} = -g_m R_c\left(\frac{2r_\pi}{2r_\pi+R_s}\right)\left(\frac{R_L}{R_L+2R_c}\right)}$$

At high frequency:

$$\omega_{HP1} = \left[\left(\frac{C_\pi}{2} + \frac{C_\mu}{2}(1-k)\right)\cdot\left(R_s \,//\, 2r_\pi\right)\right]^{-1}$$

$$\omega_{HP2} = \left[\frac{C_\mu}{2}\left(1-\frac{1}{k}\right)\cdot\left(2R_c \,//\, R_L\right)\right]^{-1}$$

$$\boxed{\omega_{HP2} = \left[\frac{C_{\mu}}{2}(1-1/K)\cdot(2R_C \parallel R_L)\right]^{-1}}$$

Since there are no coupling capacitors, low frequency is no interest for us.