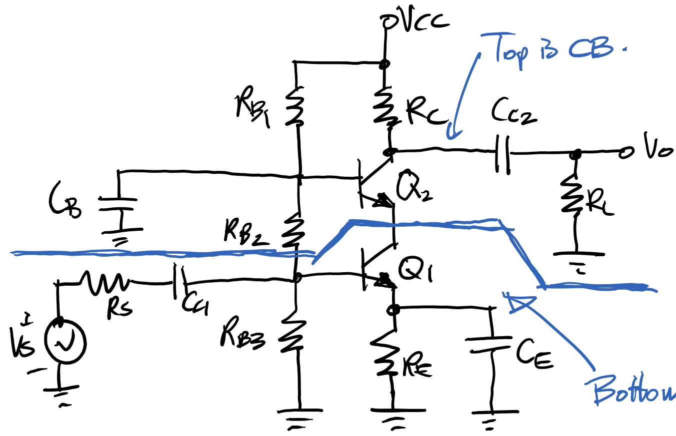
The Cascode

October 24, 2017 3:34 PM



Problem with common emitter:

Miller effect → Big capacitance

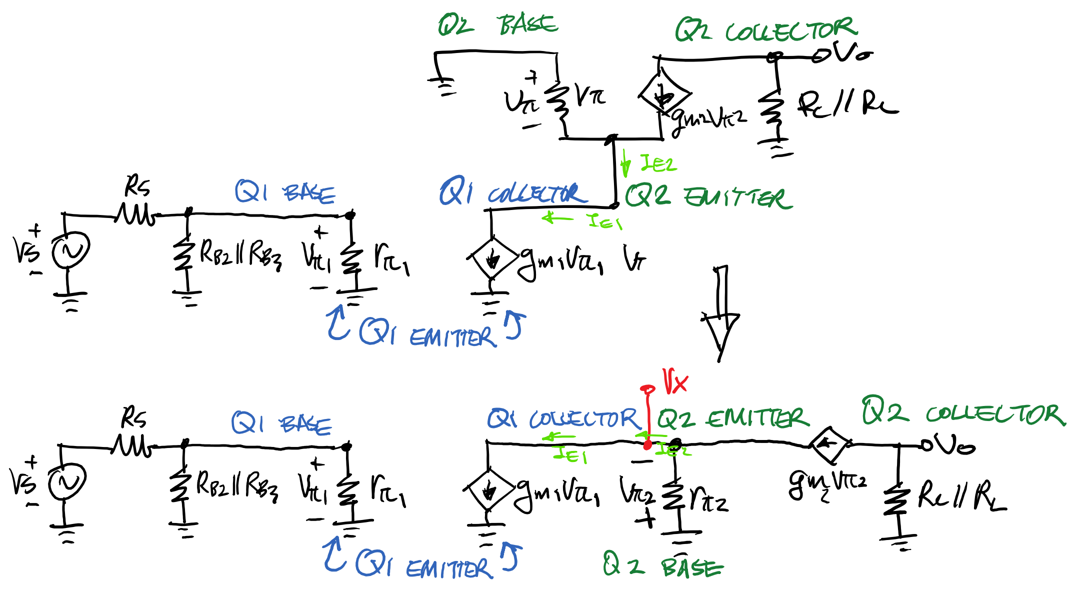
→ limited bandwidth

Problem with common base:

small. input impedance → small gain.

Usually C_B & C_E is very large. (since this model is very hard to analyze impedance)

Midband Small Signal Model



$$g_{m1}V_{\pi1} = g_{m2}V_{\pi2} + \frac{V_{\pi2}}{r_{\pi2}}$$

$$\frac{I_{C1}}{V_T}V_{\pi1} = \frac{I_{C2}}{V_T}V_{\pi2} + \frac{V_{\pi2}}{r_{\pi2}} \qquad g_{m2} = \frac{I_{C2}}{V_T} = \frac{\beta_2}{r_{\pi2}}$$

$$= \left(\frac{\beta_2+1}{r_{\pi2}}\right)V_{\pi2}$$

$$= \left(\frac{\beta_2+1}{\beta_2}\right)\frac{I_{C2}}{V_T}V_{\pi2}$$

$$I_{C1}V_{\pi1} = \left(\frac{\beta_2+1}{\beta_2}\right)I_{C2}V_{\pi2}$$

$$I_{C1}V_{\pi1} = I_{E2}V_{\pi2}$$

$I_{C1} = I_{E2}$ (emitter of Q2 is connected to collector of Q1)

$\rightarrow V_{\pi1} = V_{\pi2}$

$\rightarrow V_x = -V_{\pi1} = -V_{\pi2}$

$\rightarrow V_{\pi 1} = V_{\pi 2}$

$\rightarrow V_x = -V_{\pi 1} = -V_{\pi 2}$

$\uparrow$

Needed for Miller theorem

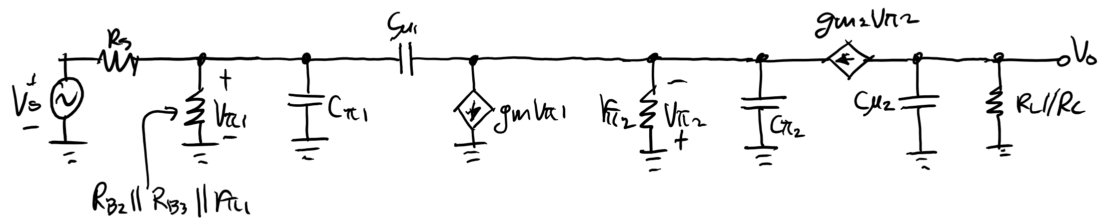
$$A_M = \frac{V_o}{V_{\pi 2}} \cdot \frac{V_{\pi 2}}{V_{\pi 1}} \cdot \frac{V_{\pi 1}}{V_s} \quad , \quad \frac{V_{\pi 2}}{V_{\pi 1}} = 1$$

$$= \frac{V_o}{V_{\pi 2}} \cdot \frac{V_{\pi 1}}{V_s}$$

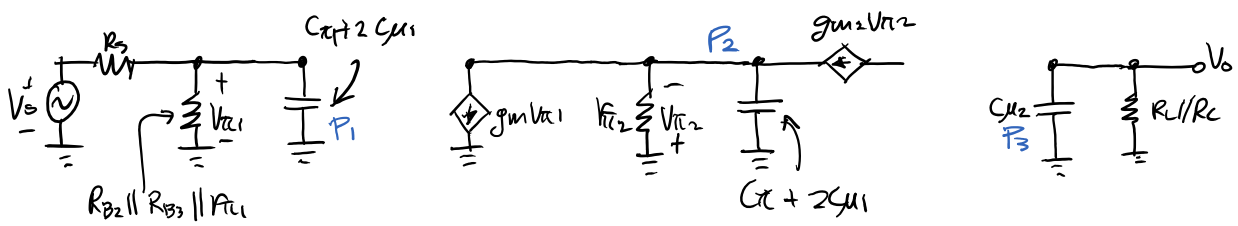
$$= \frac{-g_{m2} \cancel{V_{\pi 2}} \times R_C \| R_L}{\cancel{V_{\pi 2}}} \cdot \frac{\left(\frac{\cancel{V_s} \cdot R_{B2} \| R_{B3} \| r_{\pi 1}}{R_s + R_{B2} \| R_{B3} \| r_{\pi 1}} \right)}{\cancel{V_s}}$$

$$= -g_{m2}(R_C \| R_L) \cdot \frac{R_{B2} \| R_{B3} \| r_{\pi 1}}{R_s + R_{B2} \| R_{B3} \| r_{\pi 1}}$$

High Frequency



MILLER:



$$\omega_{HP1} = \frac{1}{(C_{\pi 1} + 2C_{\mu 1})(R_s // R_{B2} \| R_{B3} // r_{\pi 1})}$$

$$\omega_{HP2} = \frac{1}{\left(\frac{r_{\pi 2}}{1+\beta_2}\right)(C_{\pi 2} + 2C_{\mu 1})}$$

$$\omega_{HP3} = \frac{1}{(C_{\mu 2})(R_L // R_C)}$$ $\leftarrow$ possible dominant pole.