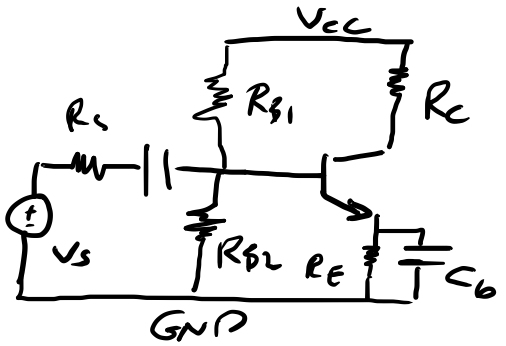
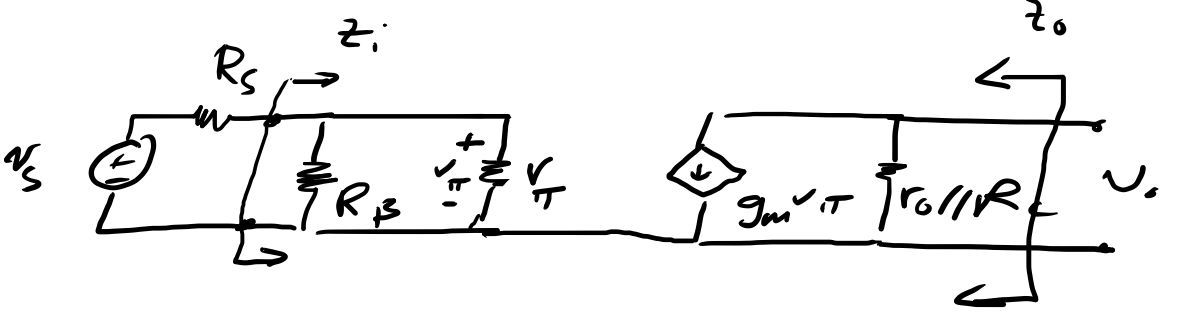
Esquema Incremental





$$z_i = \left.\frac{v_i}{i_i}\right|_{z_L=\infty \text{ (no load)}}$$

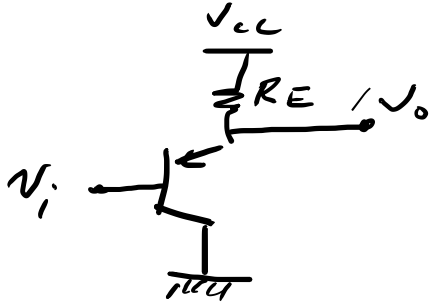
$$z_i = R_B \parallel r_\pi$$

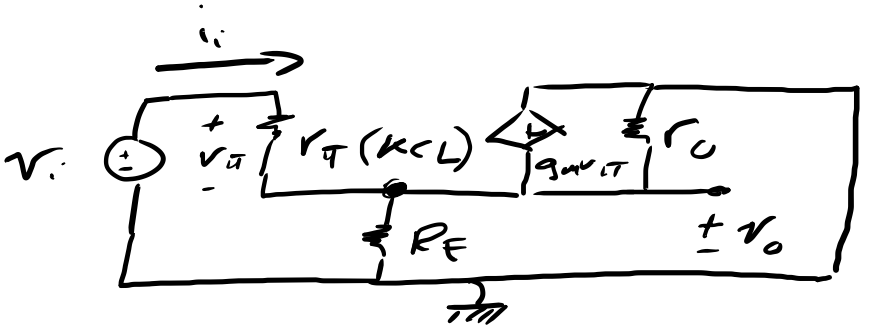
$$z_o = \left.\frac{v_o}{i_o}\right|_{v_s=0 \text{ (no input signal)}} = r_o \parallel R_C$$

$$v_o = -g_m\, r_o \parallel R_C\; v_\pi$$

$$v_\pi = \frac{R_B \parallel r_\pi}{R_B \parallel r_\pi + R_S}\, v_s$$

$$A_V = \frac{v_o}{v_s} = -g_m (r_o \parallel R_C)\, \frac{R_B \parallel r_\pi}{R_B \parallel r_\pi + R_S}$$





$$Z_i = \frac{v_i}{i_i}\Big|_{Z_L=\infty}$$

$$i_i = \frac{v_i - v_o}{r_\pi}$$

$$i_i = \frac{v_i}{r_\pi}\left(1 - \frac{g_\pi + g_m}{g_\pi + g_E + g_o + g_m}\right)$$

$$Z_o = \frac{v_o}{i_o}\Big|_{v_I=0} = \frac{1}{g_m} \| r_o \| R_E \| r_\pi$$

$$\frac{v_o - v_I}{r_\pi} + \frac{v_o}{R_E} - g_m v_\pi + \frac{v_o}{r_o} = 0$$

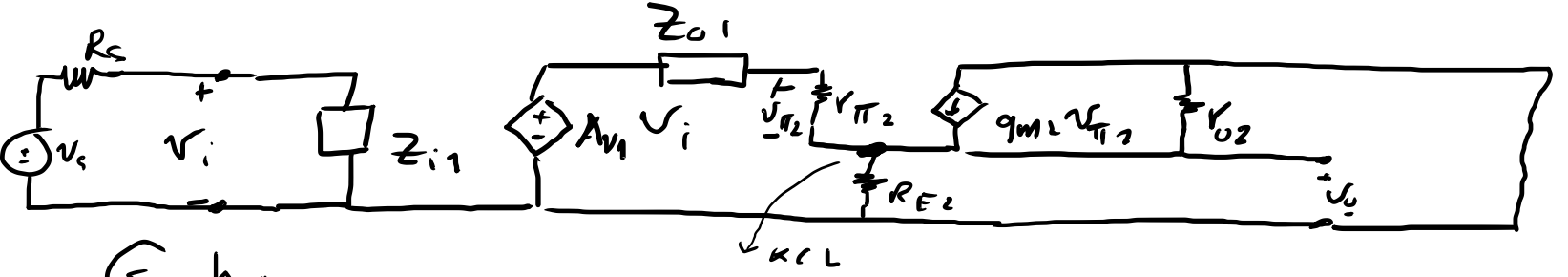
$$v_\pi = v_i - v_o$$

$$v_o\left(\frac{1}{r_\pi} + \frac{1}{R_E} + \frac{1}{r_o} + g_m\right) = v_I\left(\frac{1}{r_\pi} + g_m\right)$$

$$A_V = \frac{v_o}{v_I} = \frac{g_\pi + g_m}{g_\pi + g_E + g_o + g_m} \approx 1$$

CIRCUITO COMPLETO

O andar de saída depende de Z_{01}



Ganho

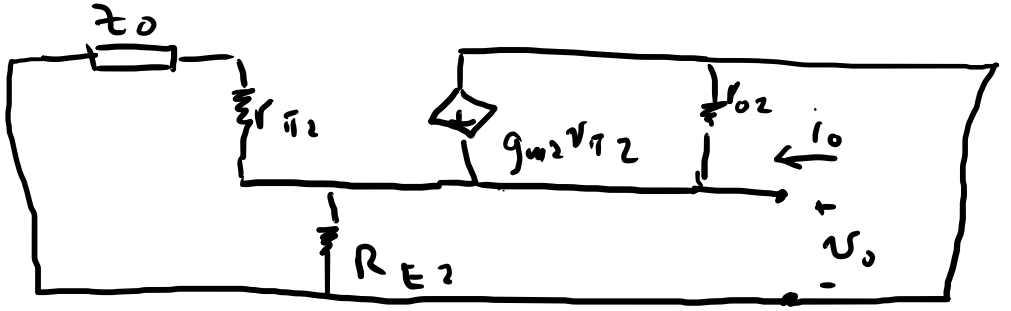
$$\frac{v_0 - A_1 v_i}{r_{\pi 2} + Z_{01}} + \frac{v_0}{R_{E2}} - g_{m2} v_{\pi 2} + \frac{v_0}{r_{02}} = 0 \quad ; \quad v_{\pi 2} = v_{\pi 2} \frac{A_1 v_i - v_0}{Z_{01} + r_{\pi 2}}$$

$$v_0 \left(\frac{1}{r_{\pi 2} + Z_{01}} + \frac{1}{R_{E2}} + \frac{1}{r_{02}} + g_{m2} \frac{r_{\pi 2}}{r_{\pi 2} + Z_{01}} \right) = \left(\frac{1}{r_{\pi 2} + Z_{01}} + \frac{g_{m2} r_{\pi 2}}{r_{\pi 2} + Z_{01}} \right) A_1 v_i$$

$$\frac{v_0}{v_i} = \frac{\frac{1}{r_{\pi 2} + Z_{01}} + \frac{g_{m2} r_{\pi 2}}{r_{\pi 2} + Z_{01}}}{\frac{1}{r_{\pi 2} + Z_{01}} + \frac{1}{R_{E2}} + \frac{1}{r_{02}} + \frac{g_{m2} r_{\pi 2}}{r_{\pi 2} + Z_{01}}} A_1$$

$$Z_i = Z_{i1}$$

Impedância de saída



$$i_0 = \frac{v_0}{r_{o2}} - g_{m2} v_{\pi 2} + \frac{v_0}{R_{E2}} + \frac{v_0}{r_{\pi 2} + z_{01}} \quad ; \quad v_{\pi 2} = -\frac{r_{\pi 2}}{r_{\pi 2} + z_{01}} v_0$$

$$i_0 = v_0 \left(\frac{1}{r_{o2}} + g_{m2} \frac{r_{\pi 2}}{r_{\pi 2} + z_{01}} + \frac{1}{R_{E2}} + \frac{1}{r_{\pi 2} + z_{01}} \right)$$

$$z_0 = \frac{v_0}{i_0} = \frac{1}{g_{o2} + g_{m2} \frac{r_{\pi 2}}{r_{\pi 2} + z_{01}} + g_{E2} + \frac{1}{r_{\pi 2} + z_{01}}}$$