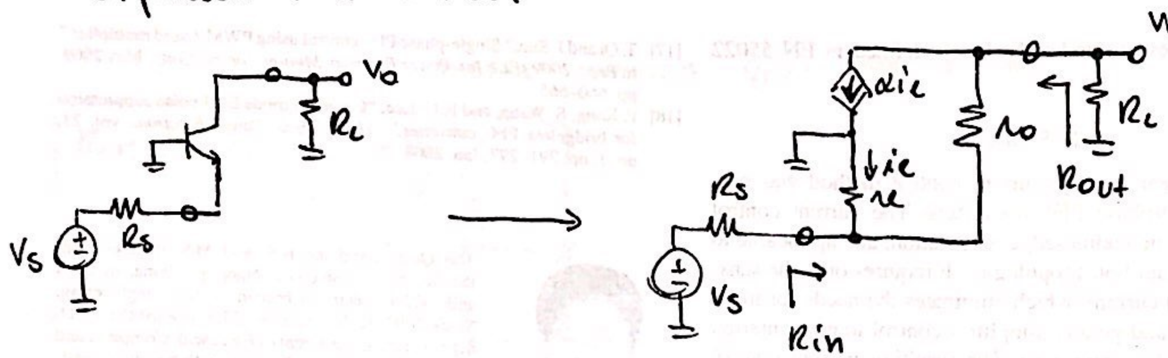
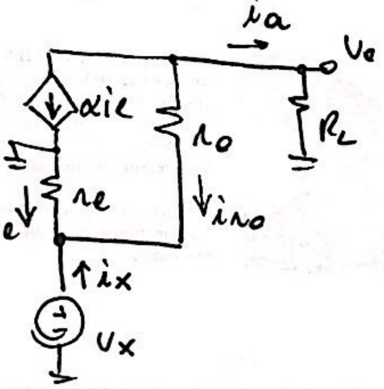
→ Análise do Base-comum

→ Expressan Rin e Rout



→ cálculo de Rin

$$R_{in} = \frac{V_x}{i_x}$$



$$i_x = -(i_e + i_{ro})$$

$$i_a = -(\alpha i_e + i_{ro})$$

$$i_x - i_a = (\alpha - 1)\, i_e$$

$$i_a = i_x + (1-\alpha)\, i_e$$

$$\rightarrow \alpha = \beta/_{\beta+1} \rightarrow \boxed{i_a = i_x + \frac{i_e}{\beta+1}}$$

$$\rightarrow V_o = i_a R_L = R_L i_x + \frac{R_L}{\beta+1} \cdot i_e$$

$$i_e = -\frac{V_x}{r_e} \longrightarrow V_o = R_L i_x - \frac{R_L V_x}{(\beta+1) r_e} = R_L i_x - \frac{R_L V_x}{r_\pi}$$

→ Como: $i_x + i_e + i_{ro} = 0$

$$i_x - \frac{V_x}{r_e} + \frac{V_o - V_x}{r_o} = 0$$

$$i_x - \frac{V_x}{r_e} - \frac{V_x}{r_o} + \frac{1}{r_o}\left(R_L i_x - \frac{R_L V_x}{r_\pi}\right) = 0$$

$$i_x \left(1 + \frac{R_L}{r_o}\right) = V_x \left(\frac{1}{r_e} + \frac{1}{r_o} + \frac{R_L}{r_o r_\pi}\right)$$

$$i_x \frac{r_o + R_L}{\cancel{r_o}} = V_x \frac{(\beta+1) r_o + r_\pi + R_L}{\cancel{r_o} r_\pi}$$

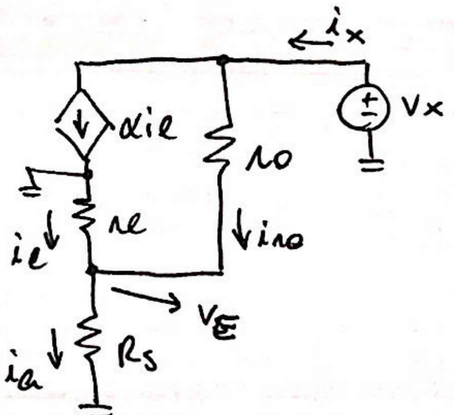
$$R_{in} = \frac{V_x}{i_x} = \frac{r_\pi (r_o + R_L)}{(\beta+1) r_o + r_\pi + R_L}$$

$$\bullet\ R_{in} = \frac{\cancel{(\beta+1)}\, r_e\,(r_o+R_L)}{\cancel{(\beta+1)}\left[r_o + r_e + R_L/_{\beta+1}\right]} = r_e \cdot \frac{(r_o+R_L)}{r_o + r_e + R_L/_{\beta+1}}$$

→ como r_e é muito menor que r_o e R_L

$$\boxed{R_{in} \cong r_e \cdot \frac{(r_o+R_L)}{r_o + R_L/_{\beta+1}}}$$

→ Cálculo de R_o



$$i_x = \alpha i_e + i_{ro}$$
$$i_a = i_e + i_{ro}$$
$$i_x - i_a = (\alpha - 1) i_e$$
$$i_a = i_x + (1-\alpha) i_e$$
$$i_a = i_x + \frac{i_e}{\beta+1}$$

$$V_e = R_S \cdot i_a = R_S i_x + \frac{R_S i_e}{\beta+1}$$

$$i_e = -\frac{V_e}{r_e} = -\frac{R_S i_x}{r_e} - \frac{R_S i_e}{r_e(\beta+1)}$$

$$i_e\left(1 + \frac{R_S}{r_\pi}\right) = -\frac{R_S}{r_e} i_x$$

$$i_e = -\frac{R_S}{r_e}\left(\frac{r_\pi}{r_\pi+R_S}\right) i_x = -\underbrace{\left(\frac{R_S r_\pi}{r_\pi+R_S}\right)}_{R_S//r_\pi}\frac{i_x}{r_e}$$

$$\boxed{i_e = -\frac{R_S//r_\pi}{r_e} \cdot i_x} \longrightarrow V_e = R_S i_x - \frac{R_S(r_\pi//R_S)}{r_\pi} i_x$$

$$\boxed{V_e = \left(R_S - \frac{R_S}{r_\pi}(r_\pi//R_S)\right) i_x} \longrightarrow V_e = \left(\frac{R_S r_\pi - R_S(r_\pi//R_S)}{r_\pi}\right) i_x$$

→ $i_x = \alpha i_e + i_{ro}$

$$i_x = -\frac{\alpha R_S//r_\pi}{r_e} i_x + \frac{(V_x - V_e)}{r_o}$$

obs: $\dfrac{\alpha}{r_e} = \dfrac{\alpha I_E}{V_T} = \dfrac{I_C}{V_T} = g_m$

$$\rightarrow i_x = \left(-g_m R_S//r_\pi\, i_x + \frac{V_x}{r_o} - \left(\frac{R_S}{r_o} - \frac{R_S}{r_o r_\pi}(r_\pi//R_S)\right) i_x\right)$$

$$i_x\left(1 + g_m(R_S//r_\pi) + \frac{R_S}{r_o} - \frac{R_S}{r_o r_\pi}(r_\pi//R_S)\right) = \frac{V_x}{r_o}$$

$$i_x\left(r_o + g_m r_o(R_S//r_\pi) - \frac{R_S}{r_\pi}\cdot\frac{R_S r_\pi}{r_\pi + R_S}\ \overset{R_S}{x}\right) = V_x$$

$$R_o = \frac{V_x}{i_x} = r_o + g_m r_o(R_S//r_\pi) + R_S - \frac{R_S}{r_\pi}(r_\pi//R_S)$$

$$R_o = r_o + g_m r_o(R_S//r_\pi) - \left[\frac{R_S(R_S//r_\pi) - R_S r_\pi}{r_\pi}\right]$$

$$R_o = r_o + g_m r_o(R_S//r_\pi) - \left[\frac{R_S(R_S r_\pi)}{r_\pi(R_S + r_\pi)} - \frac{R_S r_\pi}{r_\pi}\right]$$

$$R_o = r_o + g_m r_o(R_S//r_\pi) - \frac{(R_S r_\pi)}{r_\pi}\left[\frac{R_S}{R_S + r_\pi} - 1\right]$$

$$R_o = r_o + g_m r_o(R_S//r_\pi) - \frac{R_S r_\pi}{\cancel{r_\pi}}\left[\frac{\cancel{R_S} - \cancel{R_S} - r_\pi}{R_S + r_\pi}\right]$$

$$R_o = r_o + g_m r_o(R_S//r_\pi) + \frac{R_S r_\pi}{R_S + r_\pi} =$$

$$\boxed{R_o = r_o + g_m r_o(R_S//r_\pi) + (R_S//r_\pi)}\ //$$

Como $g_m r_o >> 1$

$$\boxed{R_o \cong g_m r_o(R_S//r_\pi)}\ //$$