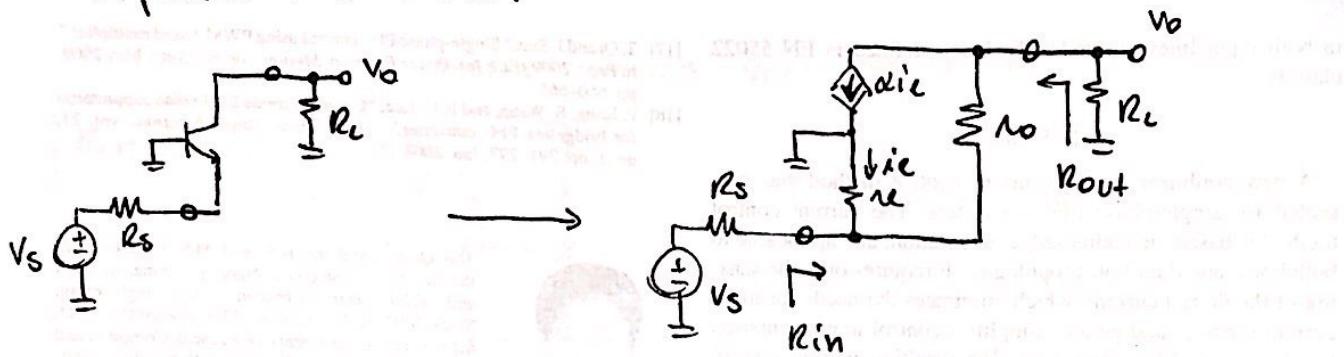
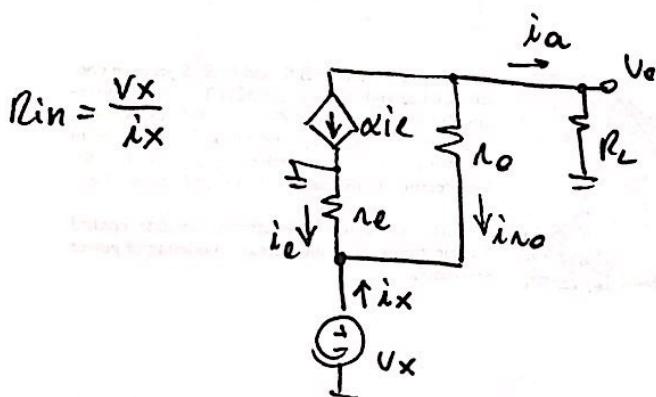


→ Análise do Base-comum

→ Expressão R_{in} e R_{out}



→ cálculo de R_{in}



$$i_x = -(i_e + i_{no})$$

$$\underline{i_a = -(\alpha i_e + i_{no})}$$

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

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

$$\rightarrow \alpha = \frac{\beta}{\beta+1} \rightarrow \underline{i_a = i_x + \frac{i_e}{\beta+1}}$$

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

$$i_e = -\frac{V_x}{n_e} \longrightarrow V_o = R_L i_x - \frac{R_L V_x}{(\beta+1)n_e} = R_L i_x - \frac{R_L V_x}{n_n}$$

$$\rightarrow \text{Como: } i_x + i_e + i_{no} = 0$$

$$i_x - \frac{V_x}{n_e} + \frac{V_o - V_x}{n_o} = 0$$

$$i_x - \frac{V_x}{n_e} - \frac{V_x}{n_o} + \frac{1}{n_o} \left(R_L i_x - \frac{R_L V_x}{n_n} \right) = 0$$

$$i_x \left(1 + \frac{R_L}{n_o} \right) = V_x \left(\frac{1}{n_e} + \frac{1}{n_o} + \frac{R_L}{n_o n_n} \right)$$

$$i_x \frac{n_o + R_L}{n_o} = V_x \frac{(\beta+1)n_o + n_n + R_L}{n_o n_n}$$

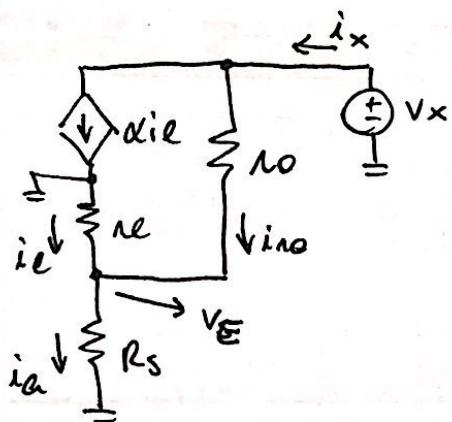
$$R_{in} = \frac{V_x}{i_x} = \frac{n_n (n_o + R_L)}{(\beta+1)n_o + n_n + R_L}$$

$$R_{in} = \frac{(B+1) r_e (r_o + R_L)}{(B+1)[r_o + r_e + R_L/\beta+1]} = r_e \cdot \frac{(r_o + R_L)}{r_o + r_e + R_L/\beta+1}$$

→ Como r_e é muito menor que r_o e R_L

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

→ Cálculo de R_o



$$i_x = \alpha i_e + i_o$$

$$i_a = i_e + i_o$$

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

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

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

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

$$i_e = -\frac{V_E}{r_E} = -\frac{R_S i_x}{r_E} - \frac{R_S i_e}{r_E(\beta+1)}$$

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

$$i_e = -\frac{R_S}{r_E} \left(\frac{r_E}{r_E + R_S}\right) i_x = -\left(\frac{R_S r_E}{r_E + R_S}\right) \frac{i_x}{r_E}$$

$$i_e = -\frac{R_S // r_E}{r_E} \cdot i_x$$

$$V_E = R_S i_x + \frac{R_S (r_E // R_S)}{r_E} i_x$$

$$V_E = \left(R_S - \frac{R_S}{r_E} (r_E // R_S)\right) i_x$$

$$V_E = \left(\frac{R_S r_E - R_S (r_E // R_S)}{r_E}\right) i_x$$

$$\rightarrow i_x = \alpha i_e + i_o$$

$$i_x = -\alpha \frac{R_S // r_E}{r_E} i_x + \frac{(V_x - V_E)}{r_o}$$

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

$$\rightarrow \text{obs: } \frac{\alpha}{r_E} = \frac{\alpha I_E}{N_A} = \frac{I_C}{N_A} = g_m$$

$$ix \left(s + gm(R_s//r_{pi}) + \frac{R_s}{r_o} - \frac{R_s}{r_{pi}r_o} (r_{pi}/R_s) \right) = \frac{V_x}{r_o}$$

$$ix \left(r_o + gm r_o (R_s/r_{pi}) - \frac{R_s}{r_{pi}} \cdot \frac{R_s r_{pi}}{r_{pi} + R_s} x \right) = V_x$$

$$R_o = \frac{V_x}{ix} = r_o + gm r_o (R_s/r_{pi}) + R_s - \frac{R_s}{r_{pi}} (r_{pi}/R_s)$$

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

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

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

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

$$R_o = r_o + gm r_o (R_s/r_{pi}) + \frac{R_s r_{pi}}{R_s + r_{pi}} =$$

$$\boxed{R_o = r_o + gm r_o (R_s/r_{pi}) + (R_s/r_{pi})}$$

~~Como $gm r_o \gg s$~~

$$\boxed{\boxed{R_o \approx gm r_o (R_s/r_{pi})}}$$

Assume $gm r_o \gg s$. Then $R_o \approx gm r_o (R_s/r_{pi})$. This approximation is valid because $gm r_o$ is much larger than s . For example, if $r_o = 10^9 \text{ m}$ and $g = 9.8 \text{ m/s}^2$, then $gm r_o \approx 10^{10} \text{ N/C}$, while s is typically around 10^{-12} N/C . Therefore, $gm r_o \gg s$.