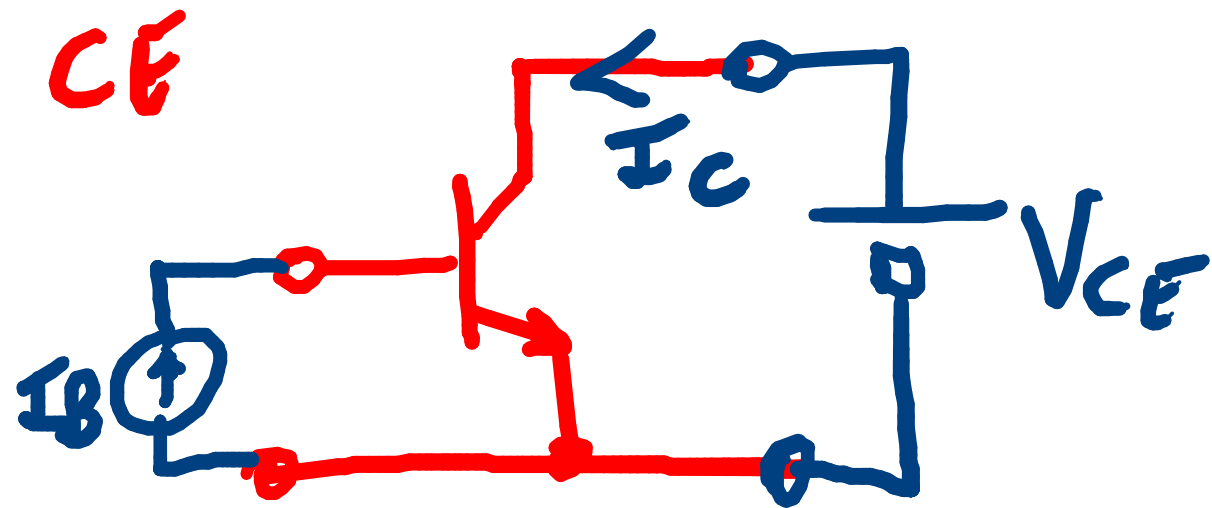
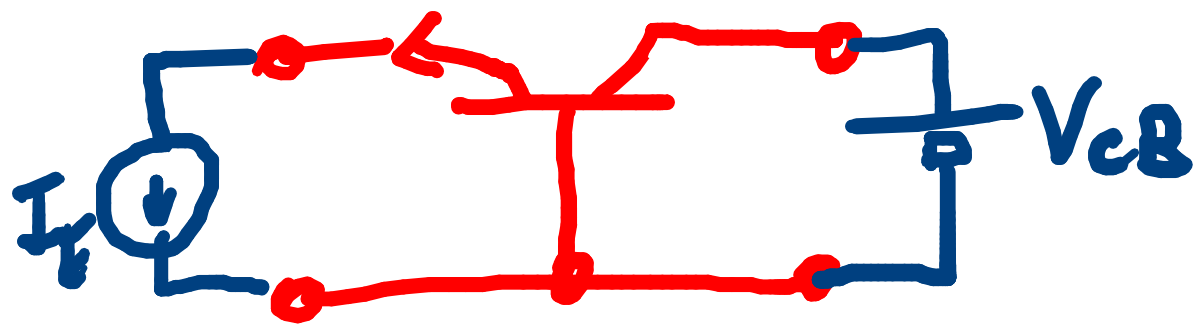


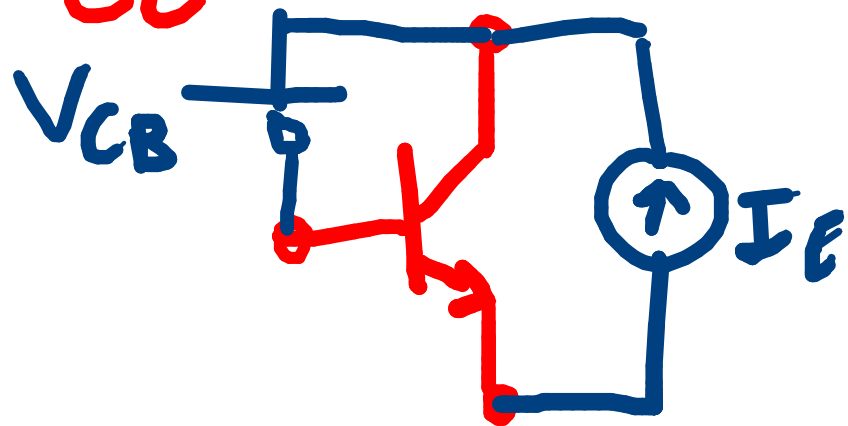
CE i_B, V_{CE}



CB

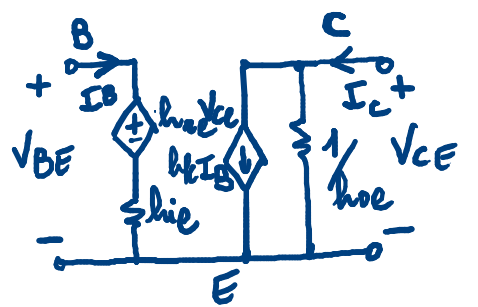
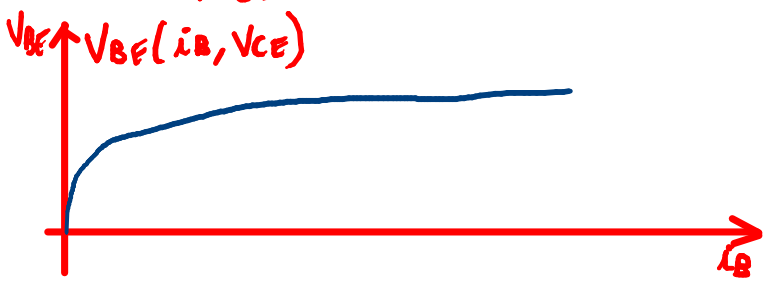
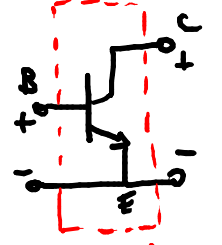


CC

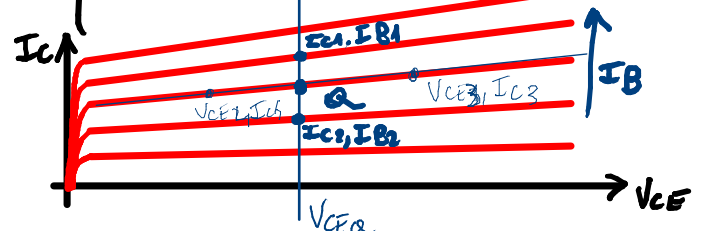




$$I_C(V_{CE}, I_B)$$



$$\begin{cases} I_C = h_{fe} I_B + V_{CE} \cdot h_{oe} \\ V_{BE} = h_{ie} V_{CE} + h_{ie} I_B \end{cases} \quad \left. \frac{\Delta I_C}{\Delta I_B} \right|_{V_{CE} = \text{const}} = h_{fe}$$



$$\left. \frac{\Delta I_C}{\Delta I_B} \right|_{V_{CE} = \text{const}} = h_{fe} = \frac{I_{C1} - I_{C2}}{I_{B1} - I_{B2}}$$

$$h_{FE} \neq h_{fe} \quad h_{FE} = \frac{I_{CQ}}{I_{BQ}} = \beta$$

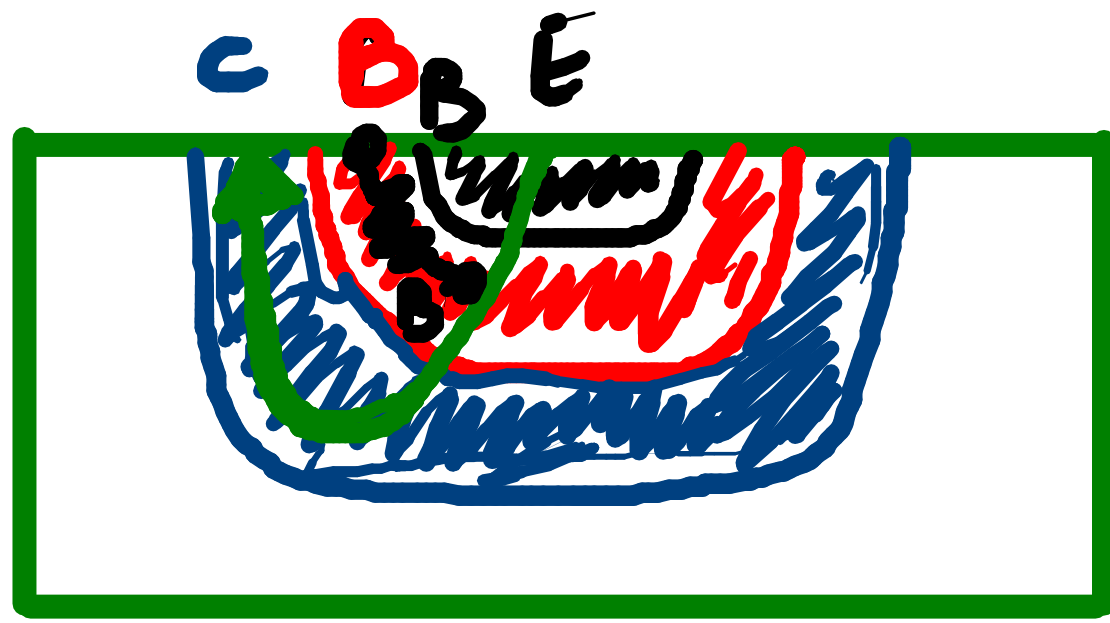
$$h_{oe} = \left. \frac{\Delta I_C}{\Delta V_{CE}} \right|_{I_B = \text{const}} = \frac{I_{C3} - I_{C4}}{V_{C3} - V_{C4}}$$

$$h_{ie} = \left. \frac{\Delta V_{BE}}{\Delta I_B} \right|_{V_{CE} = \text{const}}$$

$$i_c = I_s e^{\frac{V_{BE}}{V_T}}$$

$$i_B = \frac{i_c}{\beta} = \frac{I_s}{\beta} e^{\frac{V_{BE}}{V_T}}$$

$$\frac{\Delta I_B}{\Delta V_{BE}} = \frac{1}{\beta V_T} = \frac{1}{\beta V_T} I_s e^{\frac{V_{BE}}{V_T}} = \frac{I_C}{\beta V_T}$$



$$h_{ie} = r_{b'b'} + r_{bb'}$$

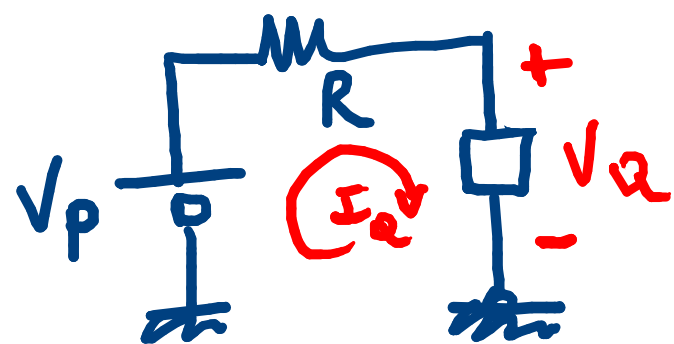
$$h_{ie} = r_{bb'} + \frac{V_T r_{be}}{I_{CQ}}$$

$$h_{ie}^* (V_{CE} = 5V; \bar{I}_C = 2mA) \quad BC109B$$

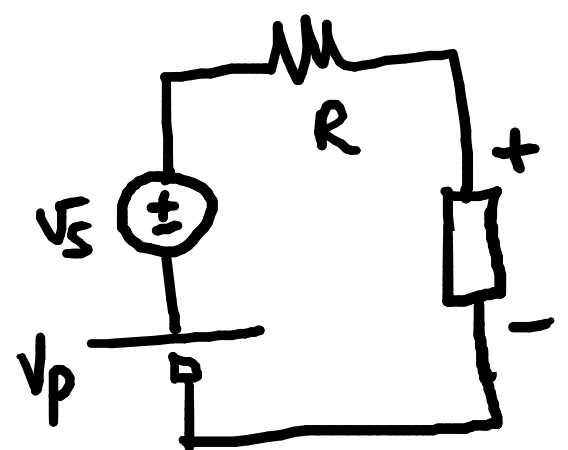
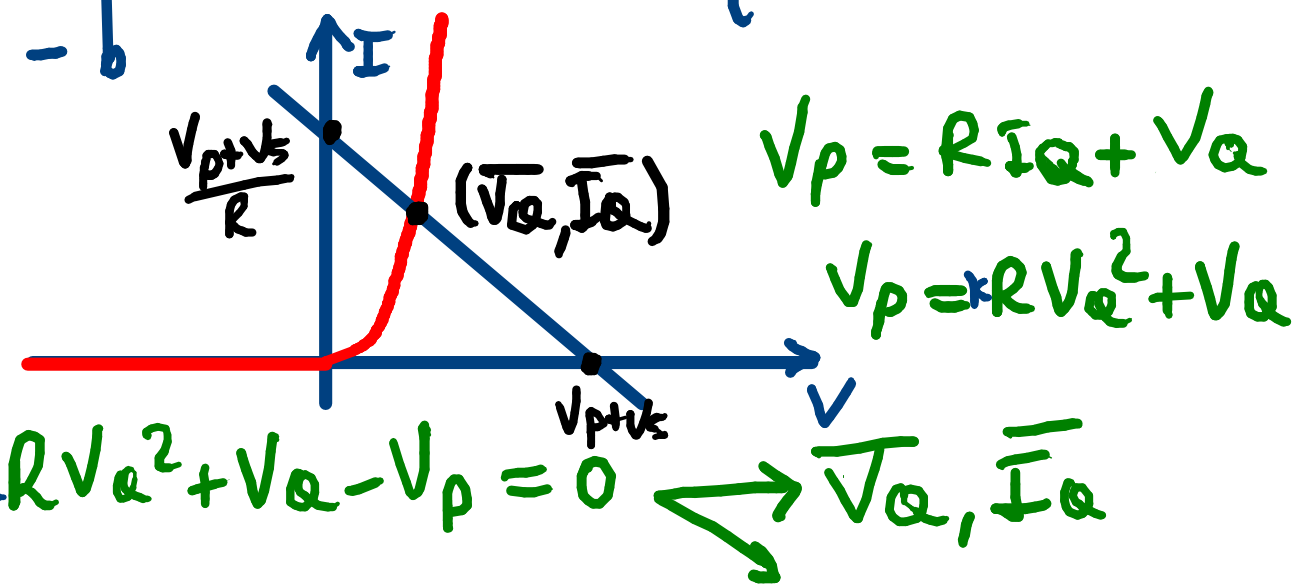
$$h_{ie}^* = 4,8k\Omega$$

$$h_{fe}^* = 300 (V_{CE} = 5V; \bar{I}_C = 2mA)$$

$$h_{ie}^* = r_{bb'} + \frac{V_T h_{fe}^*}{\bar{I}_C}$$

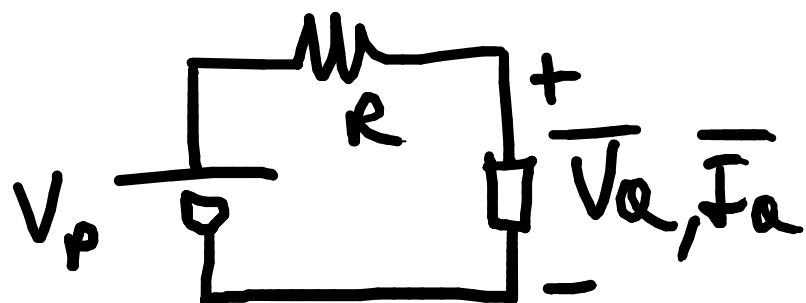


$I = f(V): \begin{cases} kV^2 & V \geq 0 \\ 0 & V < 0 \end{cases}$



$V_p \gg V_s$
 $I(V_p + V_s) \approx I_a + \left. \frac{\delta I}{\delta V} \right|_{V=V_a} V_s$

$\frac{\delta I}{\delta V} = 2kV \Big|_{V=\bar{V}_a}$



$V_{a_TOT} = \bar{V}_a + \frac{\frac{1}{2k\bar{V}_a}}{\frac{1}{2k\bar{V}_a} + R} V_s$