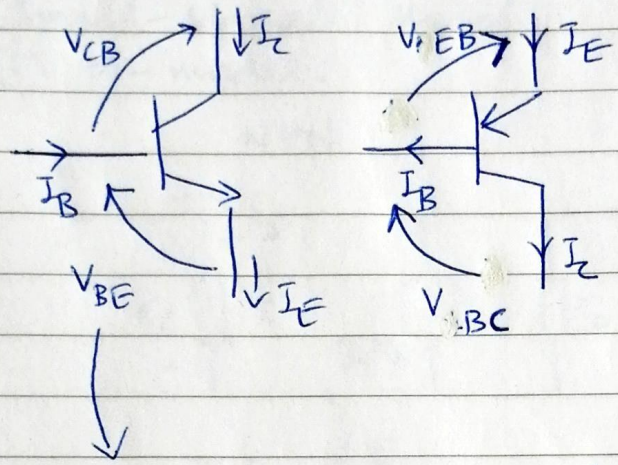
BJT Cheat sheet

Equations:



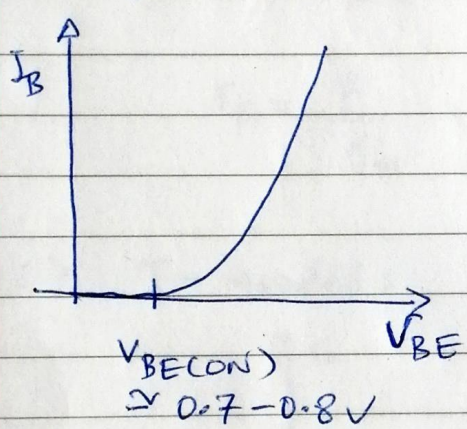
$$I_C = I_S e^{V_{BE}/V_T}$$

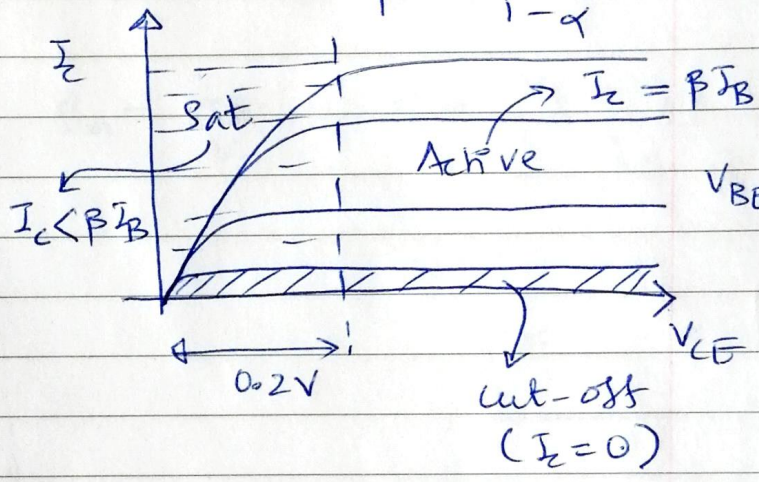
$$V_T \simeq 26\ mV$$

$$I_C = \beta I_B \qquad I_E = (1+\beta) I_B$$

$$I_C = \frac{\beta}{1+\beta} I_E = \alpha I_E \qquad (\alpha \simeq 1)$$

$$\beta = \frac{\alpha}{1-\alpha}$$

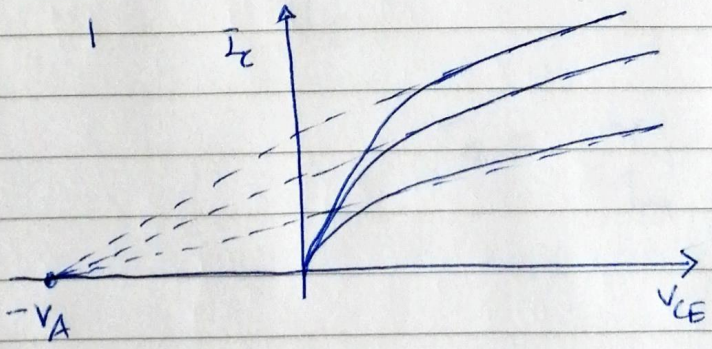




$$V_{CE} = V_{CB} + V_{BE} = V_{CB} + 0.7\ V$$

For active operation $V_{CB} \gg -0.5\ V$

Finite output Impedance:



$$I_C = I_S e^{V_{BE}/V_T} \cdot \left(1 + \frac{V_{CE}}{V_A}\right)$$

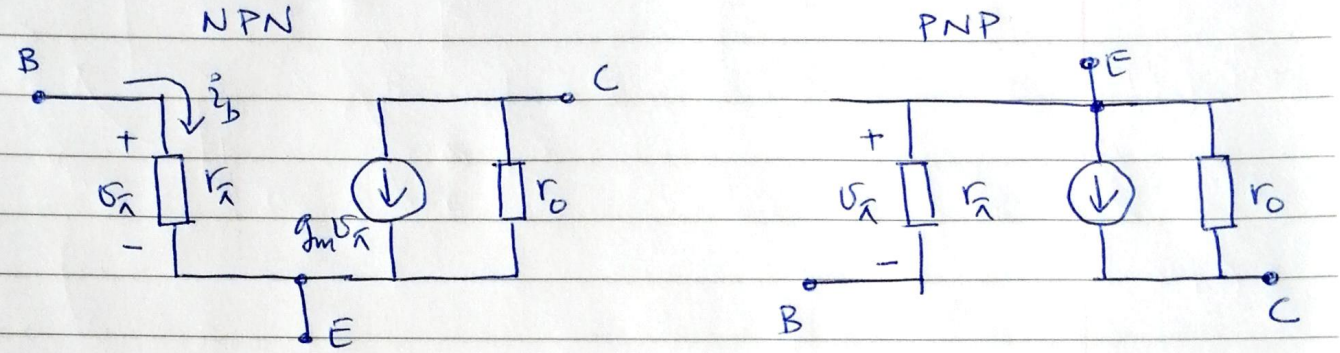
$$r_o = \left(\frac{dI_C}{dV_{CE}}\right)^{-1}$$

$$r_o \simeq \frac{V_A}{I_C'}$$

AC Equations:

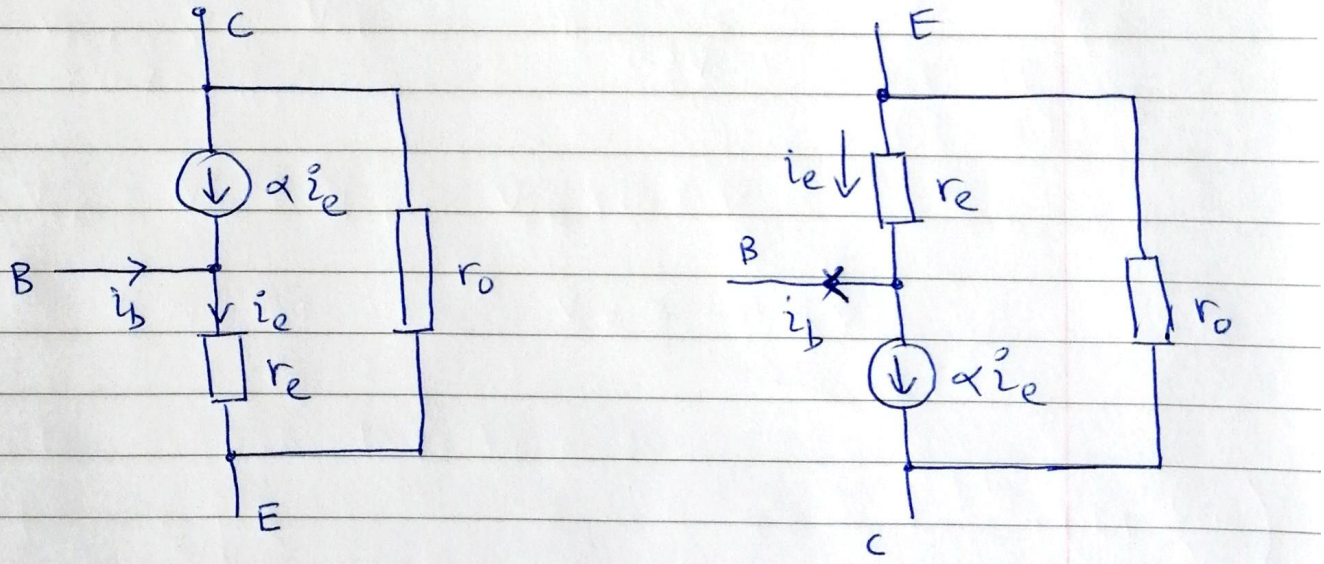
Small-signal model

(1) π-model:



$$r_\pi = \frac{\beta}{g_m} \qquad g_m = \frac{I_{CQ}}{V_T} \qquad r_o = \frac{V_A + V_{CE}}{I_{CQ}} \sim \frac{V_A}{I_{CQ}}$$

(2) T-model:



$$r_e = \frac{\alpha}{g_m} \qquad [\, r_\pi = (1+\beta) r_e \,]$$