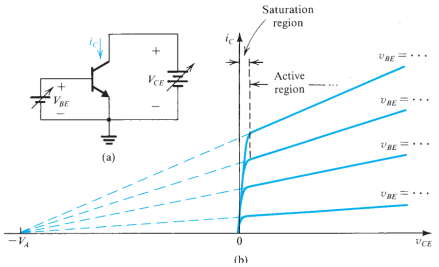
Chapter 6 - BJTs You need to go to page 357 in the text and find a bunch of the good expressions relating I_E, I_B and I_C. I_S is known as Saturation Current
We need to consider:
Base current I_B
Collector current I_C and
Collector-emitter Voltage V_{CE}

$$i_C = I_s e^{v_{BE}/V_T}$$



Considering the Early voltage

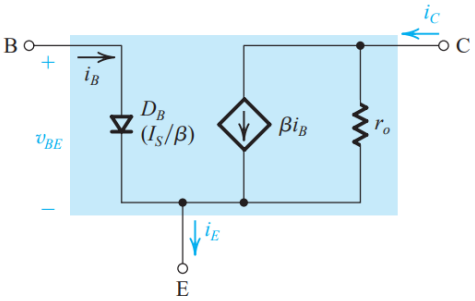
$$i_C = I_s e^{v_{BE}/V_T}\left(1 + \frac{v_{CE}}{V_A}\right)$$

$$r_o = \left[\frac{\delta i_c}{\delta v_{CE}}\Big|_{V_{BE}=\text{constant}}\right]^{-1}$$

$$r_o = \frac{V_A + V_{CE}}{I_C}$$

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

Where $I_C' = I_s e^{V_{BE}/V_T}$



$$R_{CE_{\text{SAT}}} \equiv \frac{\delta v_{CE}}{\delta i_C}\Big|_{i_B=I_B | i_C=I_{C_{\text{SAT}}}}$$

$$\frac{I_C}{I_B} = \text{transistor } \beta$$