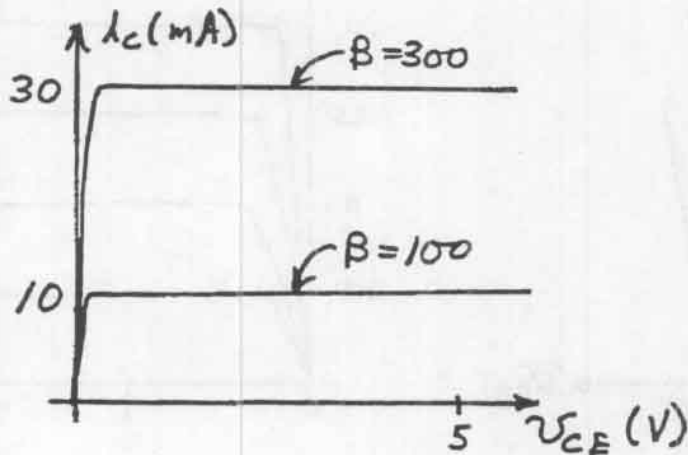


Problem 4.5



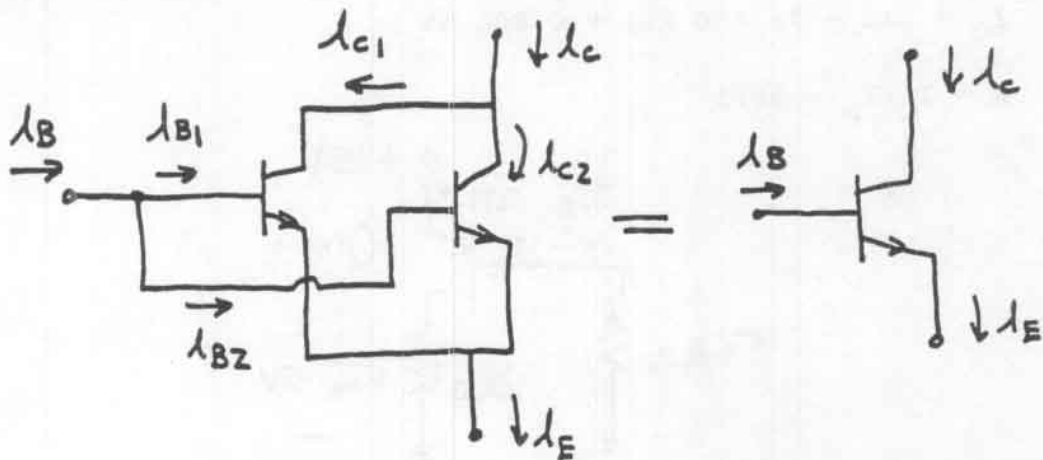
Problem 4.6

See Figure 4.5b in the book. V_A is the Early voltage and V_B is the breakdown voltage.

Problem 4.9

$$\alpha = \beta / (\beta + 1) = 50/51 = 0.9804$$

Problem 4.13



Because the transistors are identical and v_{BE} is the same for both transistors, we conclude that $i_{C1} = i_{C2}$ and $i_{B1} = i_{B2}$. Thus we have

$$\beta_{eq} = \frac{i_C}{i_B} = \frac{i_{C1} + i_{C2}}{i_{B1} + i_{B2}} = \frac{2i_{C1}}{2i_{B1}} = \beta_1 = 100$$

$$i_E = i_{E1} + i_{E2}$$

$$i_E = I_{ES1} \exp(v_{BE}/V_T - 1) + I_{ES2} \exp(v_{BE}/V_T - 1)$$

$$i_E = (I_{ES1} + I_{ES2}) \exp(v_{BE}/V_T - 1) = I_{ESeq} \exp(v_{BE}/V_T - 1)$$

Thus we conclude that

$$I_{ESeq} = I_{ES1} + I_{ES2} = 2 \times 10^{-13} \text{ A}$$