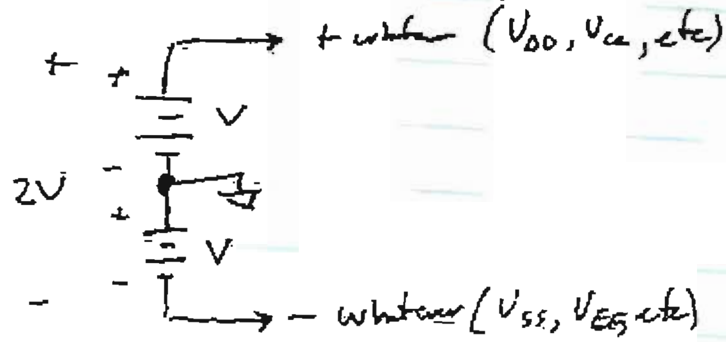
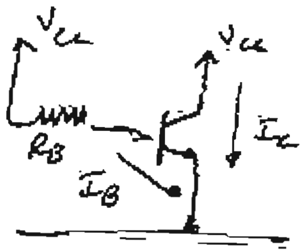




<u>DC values</u>

V_{CE} specified
I_C specified
β_{dc} device parameter

$$\beta_{dc} = \frac{I_C}{I_B}$$

"typical value"
$\beta_{dc} = 100$
$20 \le \beta_{dc} \le 400$

$$I_B = \frac{I_C}{\beta_{dc}}$$

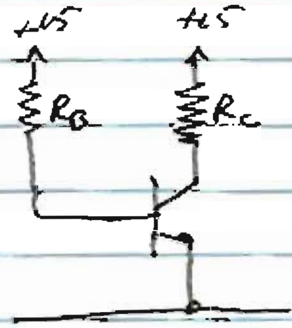
measure I_C @ fixed I_B

eg. $I_B = 10\,\mu A$

$V_{CC} = R_B I_B + V_{BE}$; $V_{BE} \simeq 700\,mV$

$$\frac{V_{CC} - V_{BE}}{I_B} = R_B$$

Measure I_C to determine actual value of β_{dc}



$R_B = 1.4M$, $I_B \simeq 10\mu A$

if $\beta_{dc} = 100$, $I_C = 1mA$

choose $V_C = 10V$

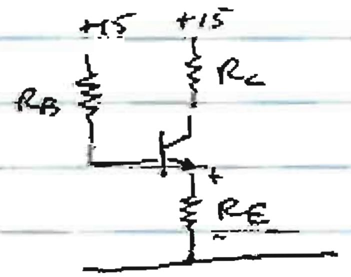
$$R_C = \frac{5}{10^{-3}} = 5K$$

$$V_C = V_{CC} - I_C R_C$$

$$15 - 5k \cdot I_C$$

if $I_C \to 3I_C$, then $V_C = 15 - 15 = 0$

not working



$$V_{CC} = R_B I_B + (I_B + I_C) R_E + V_{BE} = 0$$

$$I_C = \beta_{dc} I_B$$

$$V_{CC} = R_B I_B + (1+\beta_{dc}) R_E I_B + V_{BE} = 0$$

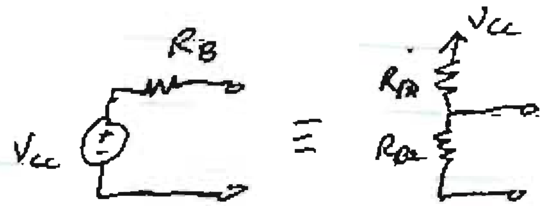
$$V_{CC} - V_{BE} = R_B I_B + (1+\beta_{dc}) R_E I_B$$

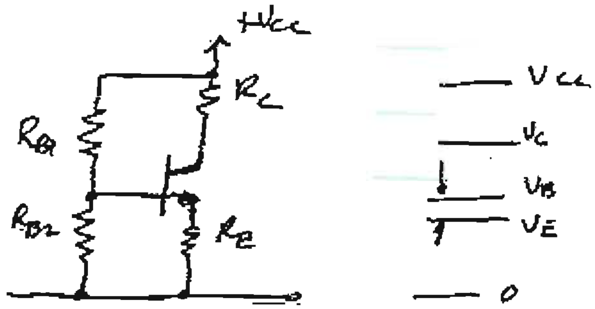
$$I_B = \frac{V_{CC} - V_{BE}}{R_B + (1+\beta_{dc}) R_E}$$

$$I_C = \beta_{dc} I_B = \frac{(V_{CC} - V_{BE})\beta_{dc}}{R_B + (1+\beta_{dc}) R_E}$$

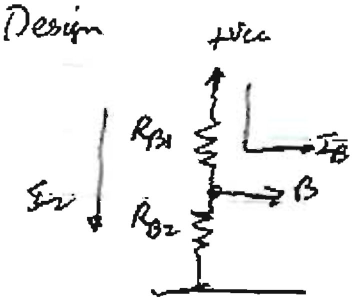
$$I_C \simeq \frac{V_{CC} - V_{BE}}{R_E}$$, if $\beta_{dc} \gg$, $R_B \simeq R_E$

≡ Thevenin Equiv





Design



$V_B = \left(\frac{R_{B2}}{R_{B1}+R_{B2}}\right)V_{cc}$ assume $I_B = 0$

But for BJT $I_B \neq 0$. Next best thing negligible I_B wrt I_2.

$\beta_{dc} I_B = I_C$. If $I_C \simeq I_2$

$I_2 = \beta_{dc} I_B$, but $\beta_{dc} >>$. Works!

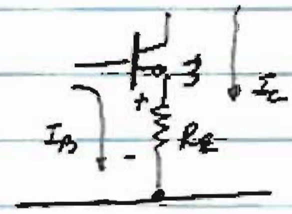
$I_2 \simeq I_C$

$\frac{R_{B1}R_{B2}}{R_{B1}+R_{B2}} = R_E$; $\left(\frac{R_{B2}}{R_{B1}+R_{B2}}\right)V_{cc} = V_B$

~~[illegible]~~ $\frac{V_{cc}}{R_{B1}+R_{B2}} \simeq I_C$

Suppose $\underline{V_{cc}} = 15$, $\underline{V_{CE}} = 5$, $\underline{V_E} = 3 \Rightarrow V_c = 8$

$I_c = 10mA$



$3 = V_E = R_E (1+\beta_{dc}) I_B$

$V_B = V_{BE} + V_E = 0.7 + 3 = 3.7$

Approx $R_E I_c \simeq V_E$

$R_E \simeq \frac{3}{10^{-2}} = \underline{300\,\Omega}$

$R_B = \underline{300\,\Omega}$

$\frac{R_{B1} R_{B2}}{R_{B1} + R_{B2}} = 300$

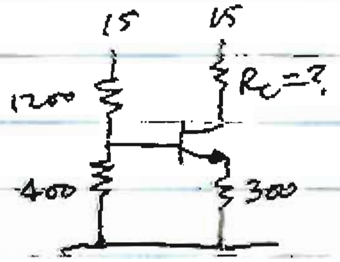
$\frac{R_{B2}}{R_{B1} + R_{B2}} = \frac{V_B}{V_{cc}} = \frac{3.7}{15} = 0.246$

$R_{B1} = \frac{300}{0.246} = 1200\,\Omega = 1.2k$

$R_{B1} R_{B2} = 300 R_{B1} + 300 R_{B2}$

$(R_{B1} - 300) R_{B2} = 300 R_{B1}$

$R_{B2} = \frac{300 R_{B1}}{R_{B1} - 300} = \frac{(300)(1.2k)}{1200 - 300} = 400\,\Omega$



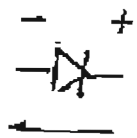
$R_c = \frac{15 - 8}{10^{-2}} = \underline{\underline{700\,\Omega}}$

I_{CBO} I_{xyz}

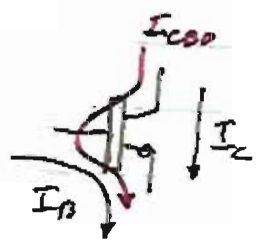
current from to; 3rd lead Open, X short

Current from Collector to Base with emitter open

I_{CBO} minority carrier current BC junction



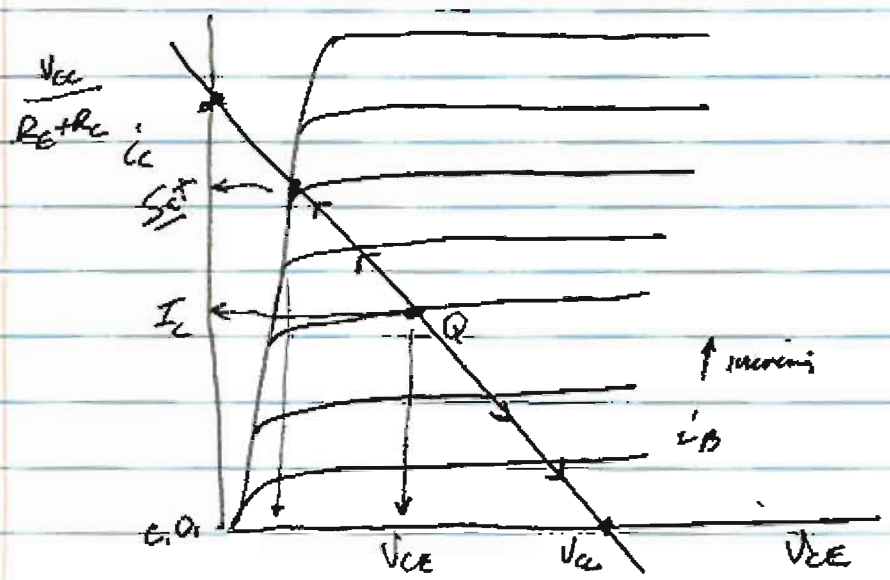
I_{CBO} is very temperature sensitive. Dramatic increase with increasing temperature.



I_B larger than designed by addition I_{CBO}

Circuit takes care of this too.

Suppose BJT is biased. For CE



load line equation

$$V_{cc} = R_C i_C + R_E (1+\beta_{dc}) \frac{i_C}{\beta_{dc}} + v_{CE}$$

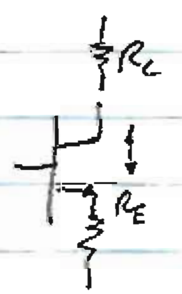
R_C drop $\quad$ R_E drop

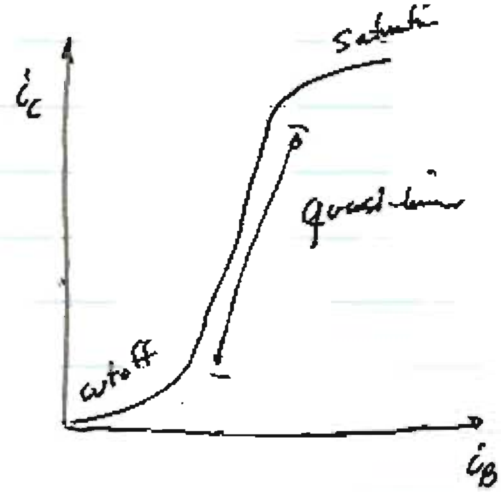
$$\frac{1+\beta_{dc}}{\beta_{dc}} \cong 1$$

$$V_{cc} \cong (R_C+R_E) i_C + v_{CE} \equiv \text{load line}$$

at saturation $\quad V_{cc} = I_C(R_E+R_C) + 0 \quad ; V_{CE} = 0$

at c.o. $\quad V_{CE} = V_{cc} \quad ; I_C = 0$





From prior plot

need small-signal parameters