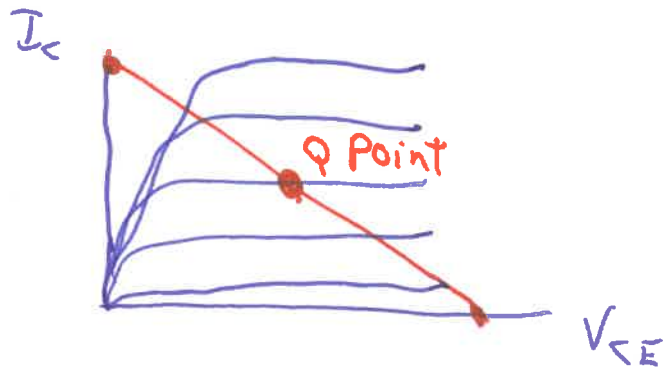
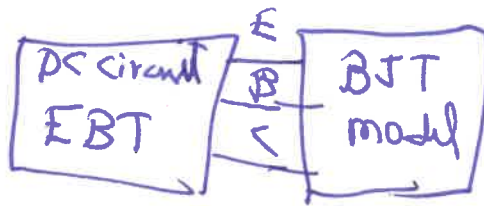


monday 24 Oct 2016

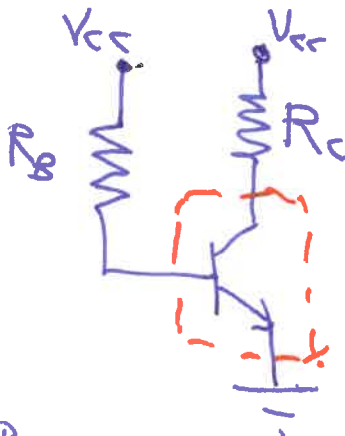
74



Goal: Stable, known Q Point (I_C)

And maybe specific DC voltage at input or output

Fixed Base



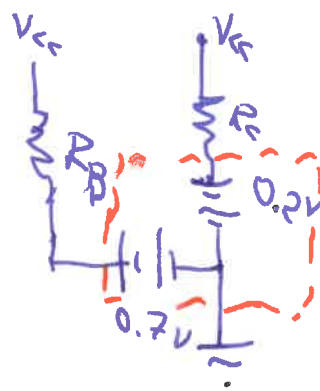
$$R_B = 200K$$
$$R_C = 1K$$

ch toff model



$$V_{CC} = +15V$$

Saturation



$$\beta = 100$$

Active



$$I_B = \frac{V_{CC} - 0.7V}{R_B} = \frac{15 - 0.7V}{200K} = 71.5 \mu A$$

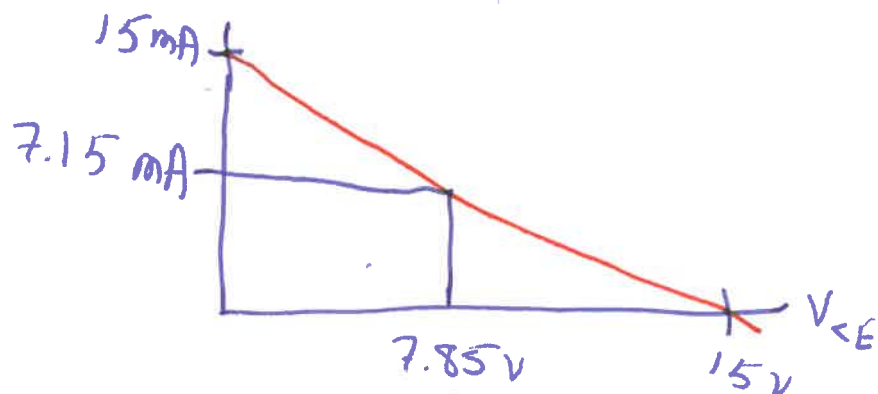
$$I_C = \beta I_B = 100 \times 71.5 \mu A = 7.15 mA$$

$$V_{CE} = V_{CC} - R_C I_C = 15V - 1K \times 7.15 mA$$
$$= 7.85V$$

$$7.85V > 0.2V, I_B > 0 \quad \text{OK!}$$

75

Well-chosen Q point



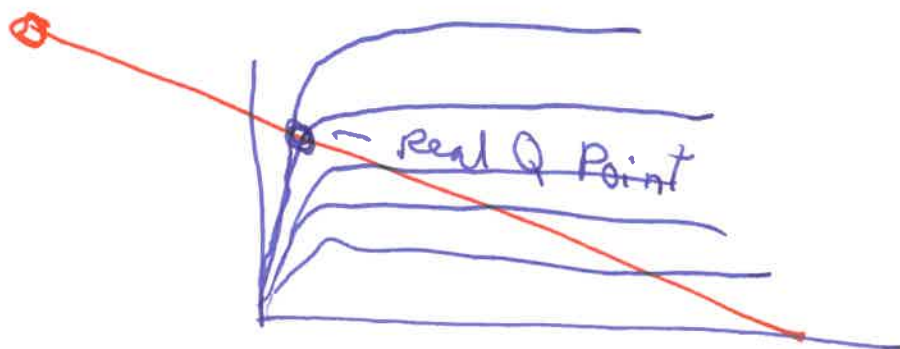
Re try with $\beta = 300$

$$I_B = 71.5 \mu A \text{ (No change)}$$

$$I_C = \beta I_B = 21.45 \text{ mA}$$

$$V_{CE} = V_{CC} - R_C I_C = -6.45 \text{ V}$$

Fail!



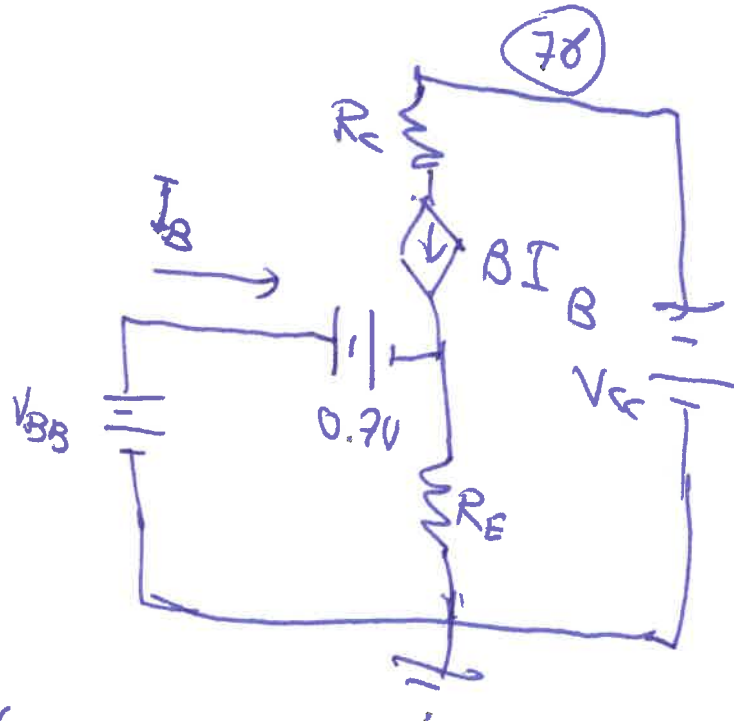
Try saturation

$$I_B = 71.5 \mu A$$

$$\beta I_B = 21.45 \text{ mA}$$

$$I_C < \beta I_B$$

Saturation



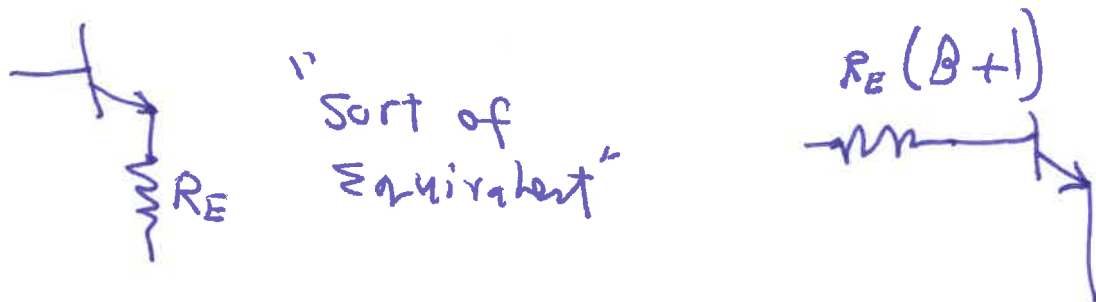
$$R_{\bar{E}} = 2 \text{ k}$$

$$I_C = \beta I_B = 2.12 \text{ mA} = \frac{\beta}{\beta + 1} I_E$$

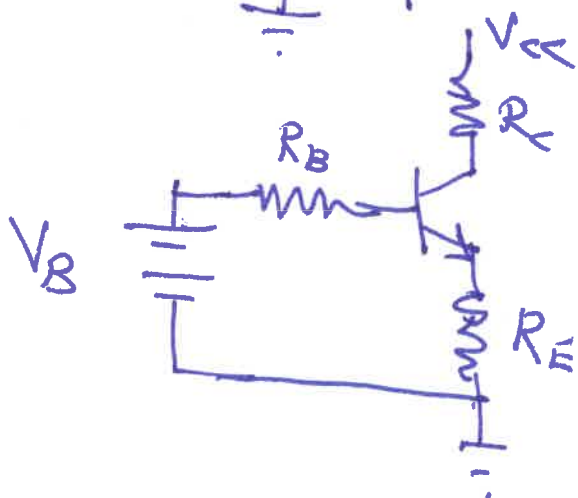
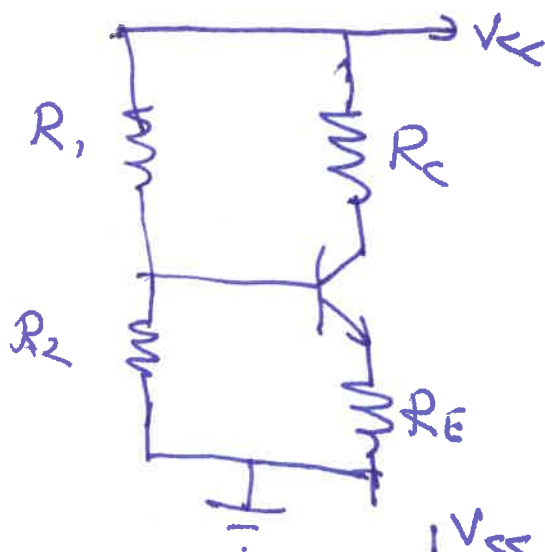
$$V_{CE} = V_{CC} - R_C I_C - R_E I_E$$

$$= 15V - 2k \times 2.12mA - 2k \times 2.15mA$$

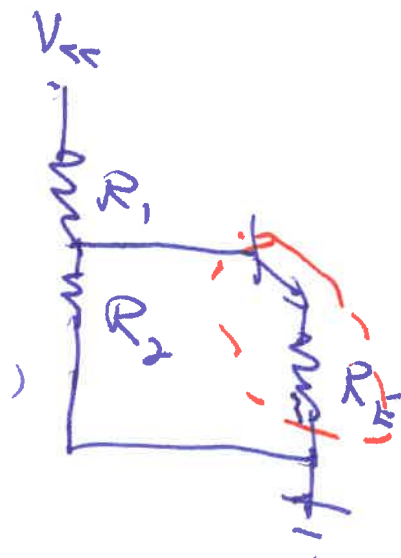
$$= 15V - 4.24V - 4.30V = 6.5V$$



1 Supply / 4 Resistors



Choose $R_2 \ll \frac{V_B}{I_{Bmax}}$



open

$$V_B = V_{cc} \frac{R_2}{R_1 + R_2}$$

short.

$$I_E = V_{cc} / R_1$$

$$R_B = R_1 \parallel R_2$$

$$\frac{V_B}{I_{sc}}$$

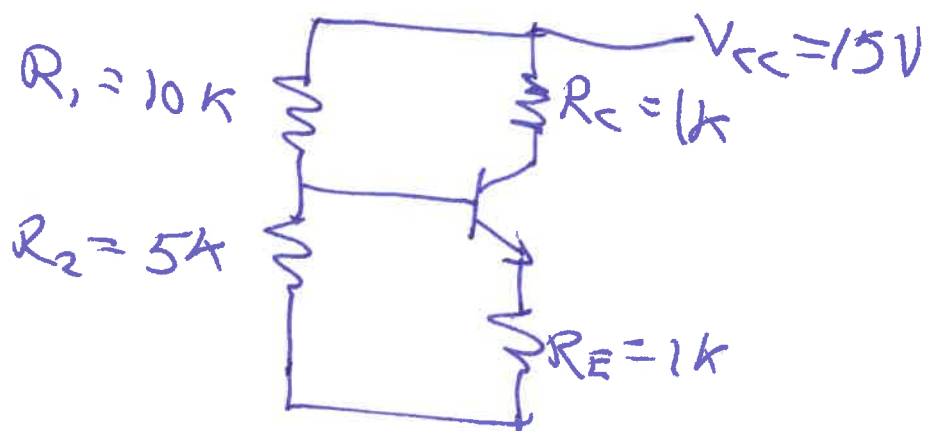
$$V_B = R_B I_B + V_{BE} + R_E (\beta + 1) I_B$$

~~$$= R_B I_B + V_{BE} + R_E (\beta + 1)$$~~

$$I_B = \frac{V_B - V_{BE}}{R_B + (\beta + 1) R_E}$$

$$I_C = \beta I_B = \beta \frac{V_{CC} \frac{R_2}{R_1 + R_2} - V_{BE}}{R_1 \parallel R_2 + (\beta + 1) R_E}$$

$$\approx \frac{\beta}{\beta + 1} \frac{V_{CC} \frac{R_2}{R_1 + R_2} - V_{BE}}{R_E}$$



$$R_B = R_1 \parallel R_2 = 3.33k \quad V_B = 5V$$

$$I_B = \frac{V_B - V_{BE}}{3.33k + (\beta + 1) 1k} \approx \frac{V_B - V_{BE}}{(\beta + 1) R_E}$$

$$\beta = 100$$

$$I_B = 41.2 \mu A$$

$$I_C = 4.12 \text{ mA}$$

$$V_{CE} = 6.72 \text{ V}$$

$$\beta = 300$$

$$4.14 \mu A$$

$$4.24 \text{ mA}$$

$$6.51 \text{ V}$$

R_2 varies 10 to 20 Times $I_{B \max}$

$$V_B \gg \Delta V_{BE}$$

$$V_B \gg \Delta V_B$$

$$V_{CE}, I_{CR}, I_E R_E$$

$\approx \text{Equal}$