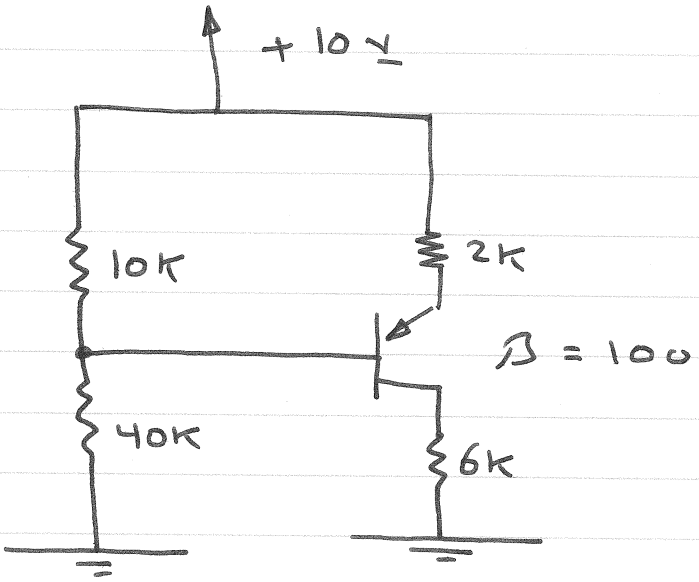
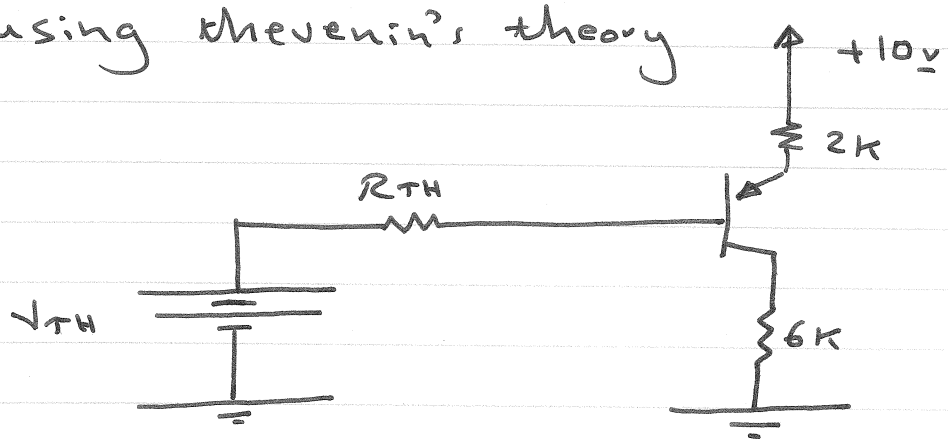
Circuit using pnp Transistor



using thevenin's theory



$R_{TH} = 10K \parallel 40K = 8K$

$$V_{TH} = \frac{40K}{10K+40K}\,10 = 8\ V$$

KVL : $10 = 2K I_E + V_{EB} + R_{TH} I_B + V_{TH}$

$\therefore I_E = 0.625\ mA$

KVL : $10 = 2K I_E + V_{EC} + 6K I_E$

$\therefore V_{EC} = 5\ V$

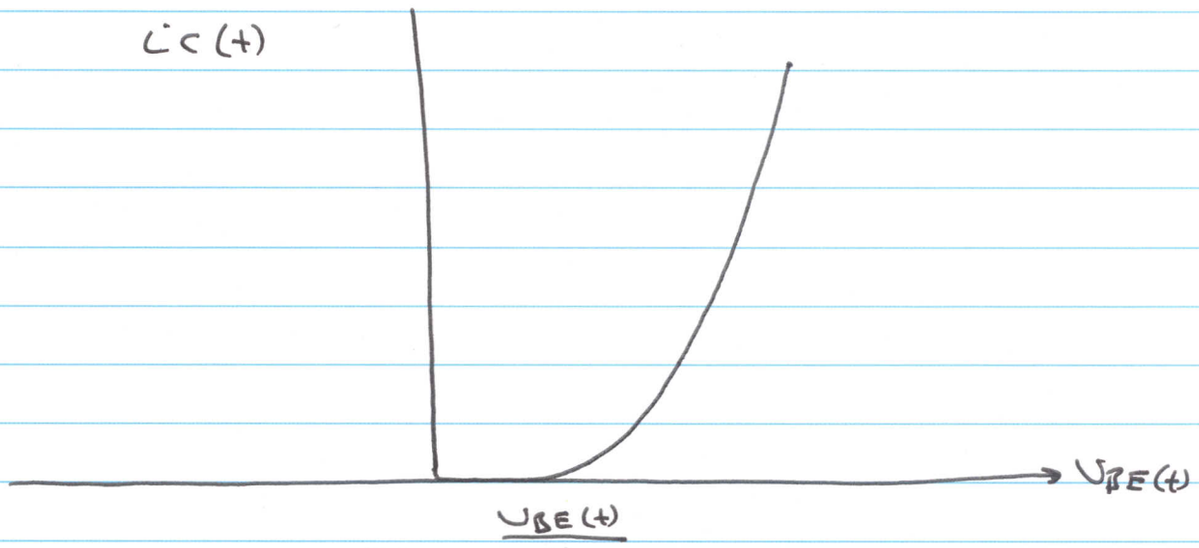
Example

Design the given circuit so that

$I_{CQ} = 2mA$, and $V_C = 5V$

given that $V_{BE} = 0.7V$ @ $I_C = 1mA$

$\beta = \infty$



$$i_C(t) \cong I_S \, e^{\frac{V_{BE}(t)}{V_T}}$$

$$I_C \cong I_S \, e^{\frac{V_{BE}}{V_T}}$$

$$V_{BE} = V_T \ln \frac{I_C}{I_S}$$

in our circuit $I_C = 2mA$, we must find the corresponding V_{BE}

$V_{BE} = ?$ @ $I_C = 2mA$

$$V_{BE_1} = 0.7 = V_T \ln \frac{1mA}{I_S}$$

$$V_{BE_2} = ? = V_T \ln \frac{2mA}{I_S}$$

$$V_{BE_2} - V_{BE_1} = V_T \ln \frac{I_{C_2}}{I_{C_1}}$$

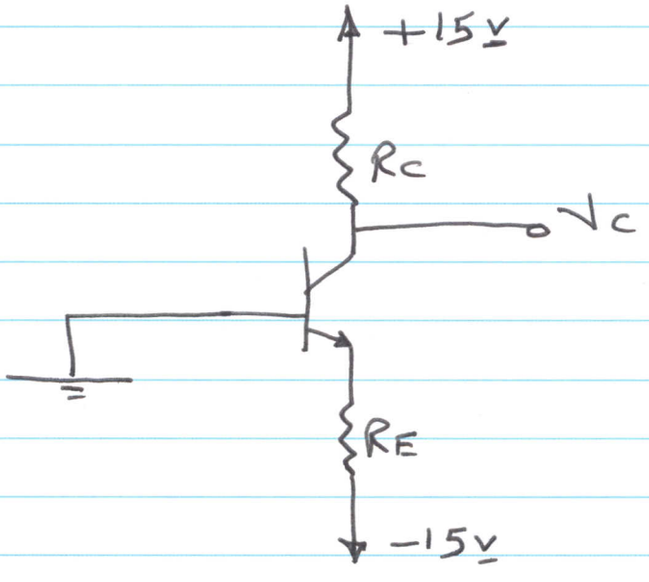
$$V_{BE_2} = V_{BE_1} + V_T \ln \frac{2mA}{1mA}$$

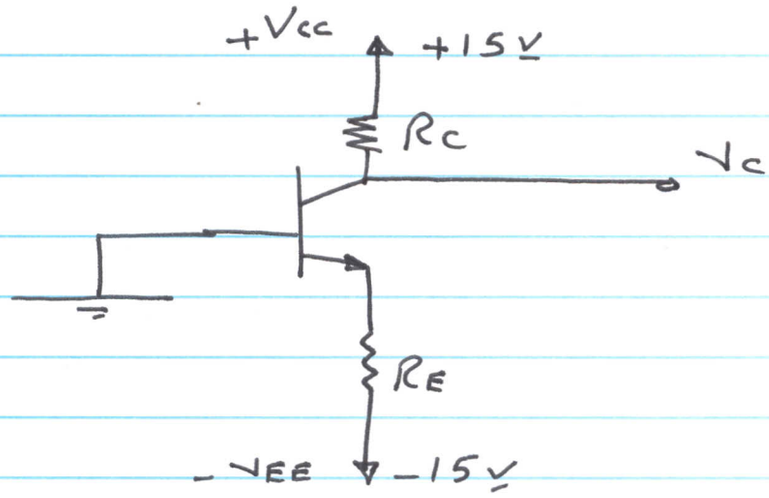
$$\therefore V_{BE_2} = 0.717 \text{ V}$$

$\therefore$

$$V_{BE} = 0.717 \text{ V} \text{ @ } I_C = 2mA$$

The circuit that to be designed is





$$V_c = V_{cc} - R_c I_c$$

$$\therefore R_c = \frac{V_{cc} - V_c}{I_c}$$

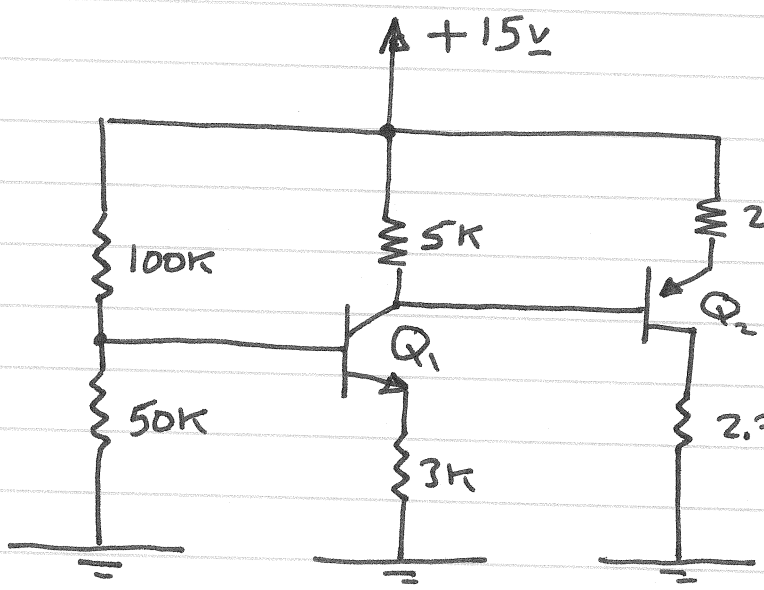
$$R_c = \frac{15-5}{2mA} = 5K$$

KVL :

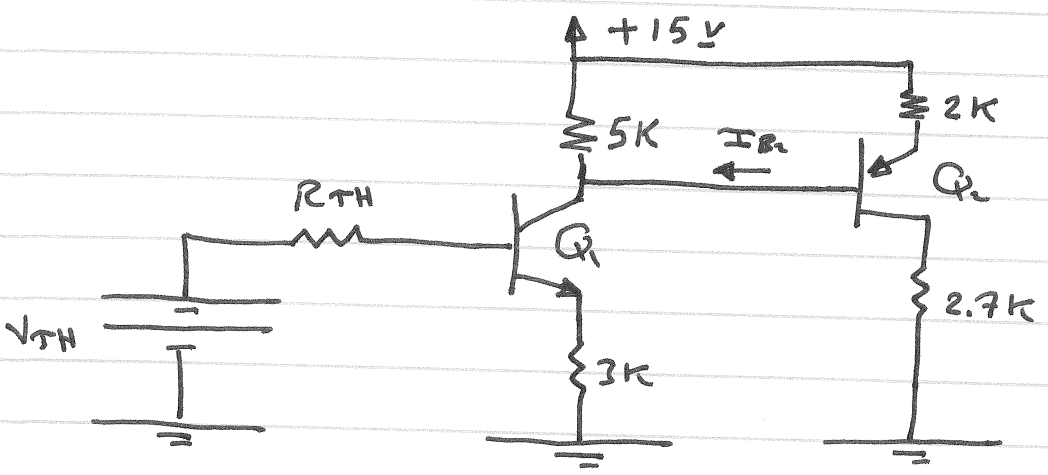
$$V_{BE} + R_E I_E - 15 = 0$$

$$\therefore R_E = \frac{15 - V_{BE}}{I_E} = 7K$$

Example



$\beta = 100$



$$R_{TH} = 50K \parallel 100K = 33.3K$$

$$V_{TH} = \frac{50K}{50K+100K} \cdot 15 = 5V$$

KVL : $$I_{E_1} = \frac{V_{TH} - 0.7}{\frac{R_{TH}}{\beta+1} + 3K} = 1.28\,mA$$

KVL : $$2K\,I_{E_2} + V_{EB} - 5K\,(I_{C_1} - I_{B_2}) = 0$$

$$\therefore \quad I_{E_2} = 2.78\,mA$$

Automatic Light Controller

In daytime

R_{Pc} is small, so that

$V_{BE} < 0.7V$

$\therefore$ Transistor is in cutoff

$\therefore$ Relay is deenergized

$\therefore$ Switch is open

$\therefore$ Lamp is OFF

At night

R_{Pc} becomes Large, so that

$V_{BE} \approx 0.7V$

$\therefore$ The Transistor is on

$\therefore$ Relay is energized

$\therefore$ Switch is close

$\therefore$ Lamp is On