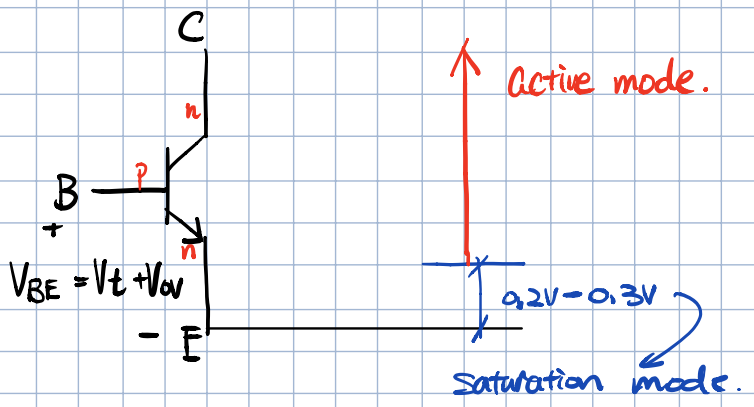
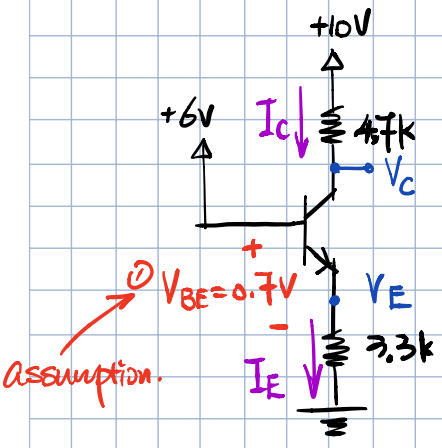
BJT DC circuits.



Example.1 $\beta \geq 50$ for active mode.



1) Not likely to be in cut-off mode.

2) assume in active mode.

② $V_E = 6 - 0.7 = 5.3V$

③ $I_E = \frac{V_E}{3.3k} = 1.6mA$.

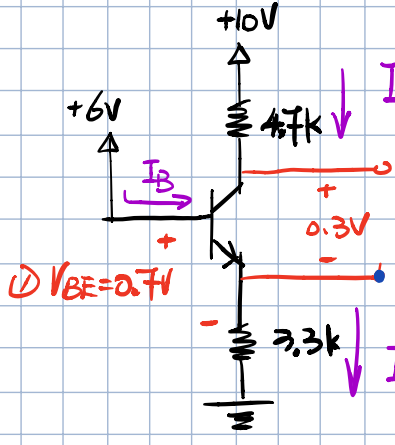
④ $I_C = \frac{\beta}{\beta+1} I_E \simeq 1.6mA$

⑤ $V_C = 10 - (4.7k) I_C = 2.48V$

$V_C < V_E$

∴ Assumption is wrong.

3) It must be in Saturation mode!



$I_C = \frac{10 - V_C}{4.7k} = 0.94mA$ ⑤

$V_C = V_E + 0.3V$ ④ ①

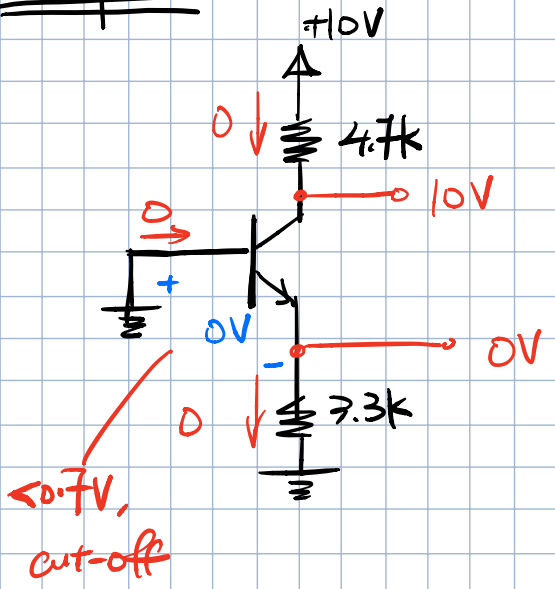
$V_E = 6V - V_{BE} = 5.3V$ ②

$I_E = V_E / 3.3k = 1.6mA$ ③

$I_B = I_E - I_C = 0.66mA$ ⑥

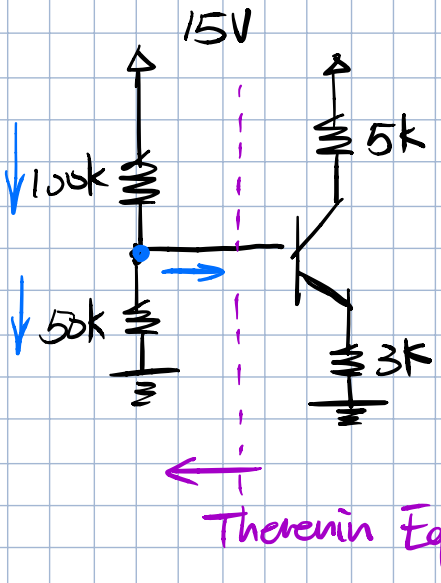
$\beta_{force} = \frac{I_C}{I_B} = 1.42$ ⑦

Example 2.



in cut-off mode.

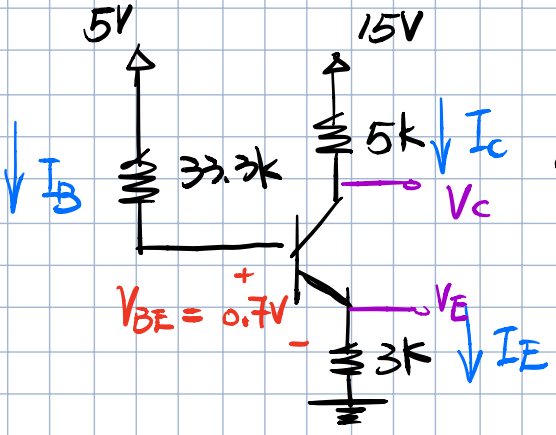
Example 3 $\beta=100$ in active mode



$$5V = \frac{50}{100+50} \times 15V$$

$100k // 50k = 33.3k$

Thevenin Equivalent. ckt.



assume. active mode (first)

$$5V = (3k)I_E + 0.7V + (33.3k)I_B$$

$$I_E = (\beta+1) I_B$$

$\rightarrow I_B = 0.0128mA$ and

$I_E = (100+1)\ 0.0128mA$

$= 1.29mA$

$V_C = 15 - 5k \times I_C = 8.6V$

$V_E = 3k \times I_E = 3.87V$

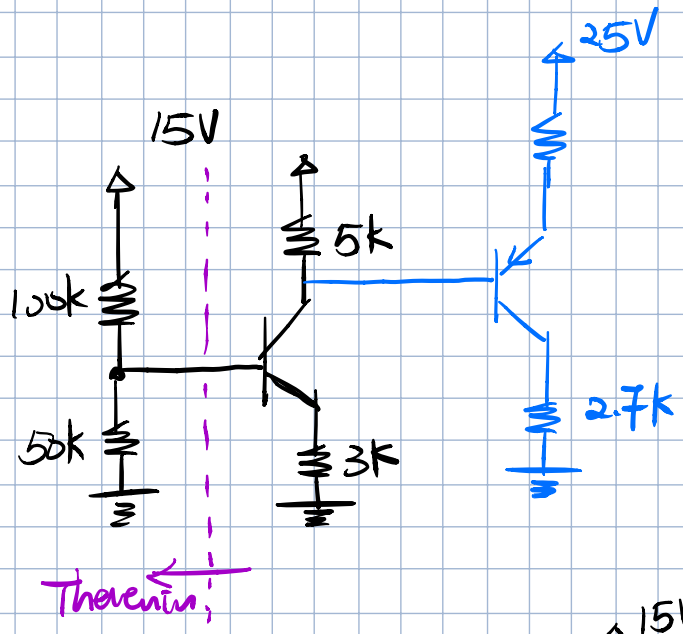
$V_C > V_E$ good :)

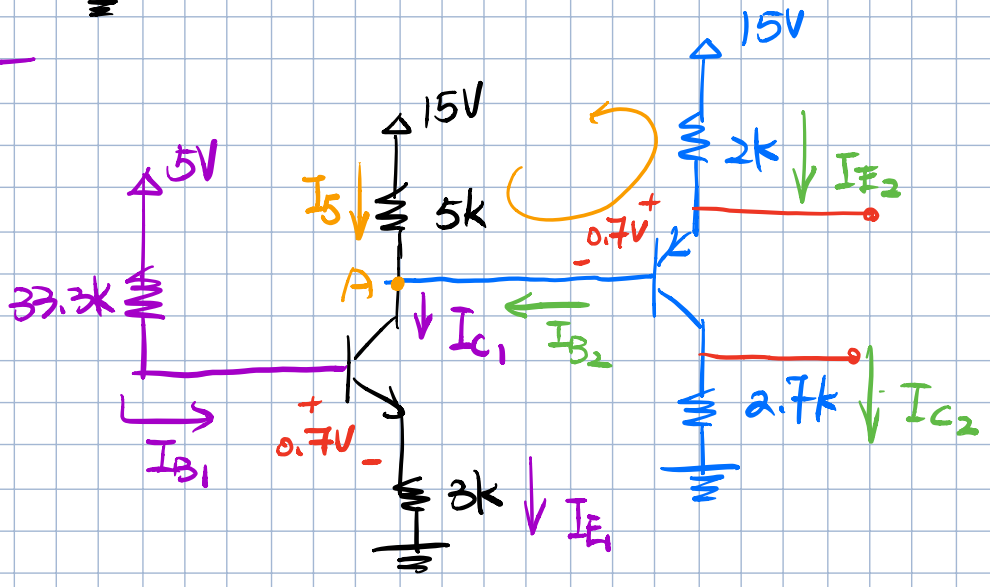
$V_{CE} > 0.2V$

$I_C = I_E - I_B = 1.28\,mA$

→ assumption correct.

Example 4. ($\beta = 100$ in active mode)





KVL:

$3k I_{E1} + 0.7V + 33.3k\, I_{B_1} = 5V$, $I_{B_1} = I_{E_1}/\beta+1$

$I_{E_1} = 1.29\,mA$ $\quad I_{C_1} = \frac{\beta}{\beta+1} I_{E_1} = 1.28\,mA$

KCL @ A: $I_5 + I_{B_2} = I_{C_1}$ $\quad I_5 = I_{C_1} - I_{B_2}$

KVL:

$5k(I_5) = 0.7 + 2k(I_{E_2})$, 因为两边都是从 Node A $\rightarrow$ 15V

$$I_{B_2} = \frac{I_{E_2}}{\beta+1}$$

$$\Rightarrow 5k(I_{C_1} - I_{B_2}) = 0.7 + 2k(I_{E_2}), \quad I_{E_2} = 2.75mA$$

$$I_{C_2} = \frac{\beta}{\beta+1} I_{E_2}$$

$$I_{C_2} = 2.75\,mA$$