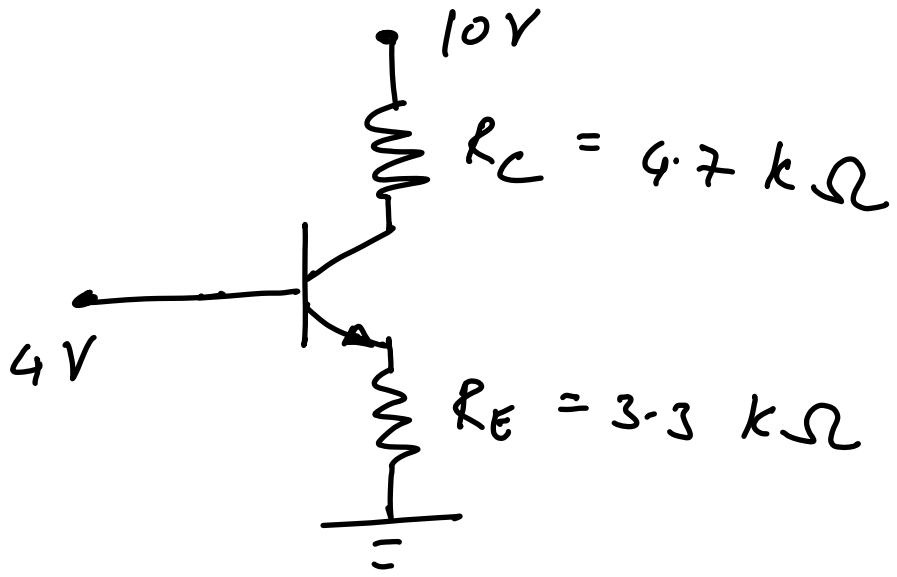
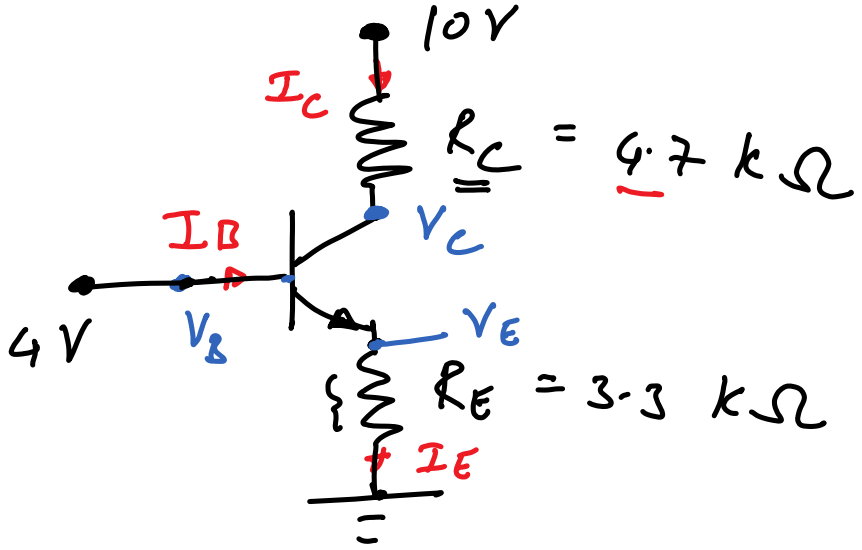
EXAMPLE 1



Compute V_C, V_E, V_B, I_E, I_B, I_C & assume $\beta = 100$

Assume BJT is in active mode. We will check this assumption eventually.



$10 - V_C = I_C R_C$ -①

$4 - V_B = 0$

$\Rightarrow \boxed{V_B = 4}$ ✓

$V_E - 0 = I_E R_E$ -②

$\{V_C, I_E, V_E, I_C\}$ ✗

$V_B - V_E = 0.7$

$4 - V_E = 0.7$

$\boxed{V_E = 3.3\ V}$

$I_C = \beta I_B$ -③

$I_E = I_C + I_B$ -④

V_C, V_E ✓, V_B ✓, I_C, I_B, I_E

$$\begin{cases} 10 - V_C = I_C R_C & -① \\ 3.3 = I_E R_E & -② \\ I_C = \beta I_B & -③ \\ I_E = I_C + I_B & -④ \end{cases}$$

① → $V_C = 5.34\ V$

② → $I_E = 1\ mA$

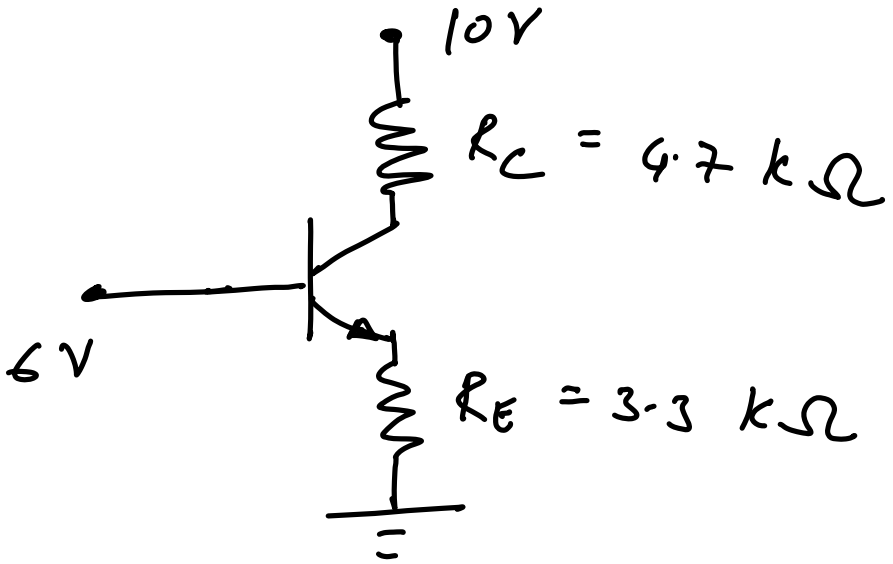
③, ④ → $I_C = 0.99\ mA$, $I_B = 0.01\ mA$

Check assumptions of active mode

$I_B, I_C > 0$ ✓ $V_{BE} = 0.7\ V$ assumed ; $I_C = \beta I_B$ ✓

$V_C = V_c - V_E = 5.34 - 3.3 = 2.04 > 0.2$

EXAMPLE 2

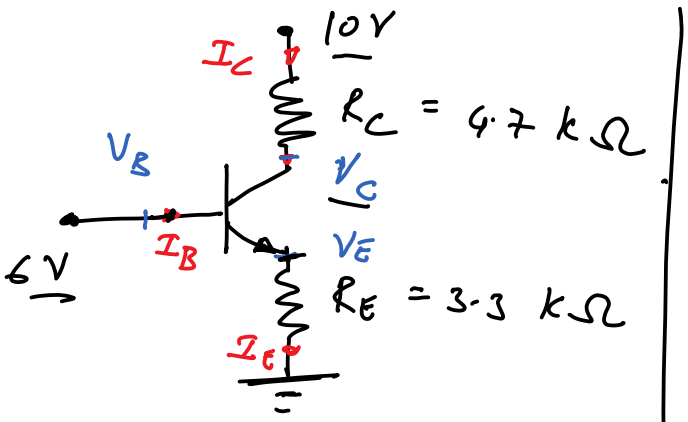


Check if the BJT is in active mode ($\beta = 100$)

Assumptions of active mode

$I_C, I_B > 0$ $\quad V_{BE} = 0.7$ $\quad V_{CE} \geq 0.2$?

$I_C = \beta I_B$



$V_{CE} = V_C - V_E = ?$

$V_{CE} = V_C - V_E$

$= 2.25 - 5.3$

$= -3.05 \leq 0.2$

(condition is false, BJT is NOT in active mode)

$V_E - 0 = I_E R_E$

$10 - V_C = I_C R_C$

$V_B = 6$

$V_{BE} = V_B - V_E = 0.7$

$6 - V_E = 0.7$

$V_E = 5.3$

Cont'd,

$I_C = \beta I_B \quad ; \quad I_E = I_C + I_B$

$I_E = \frac{V_E}{R_E} = \frac{5.3}{3.3 \times 10^3} = 1.67\ mA$

$I_C + I_B = 1.67$

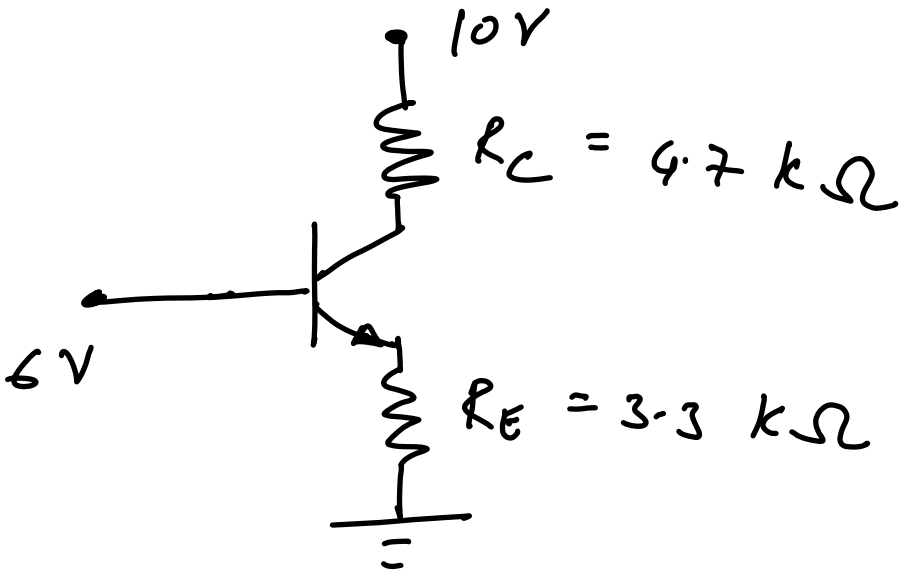
$I_C = \beta I_B$

$I_C = 1.65\ mA$

$I_B = 0.02\ mA$

$10 - V_C = 1.65\ (10^{-3})\ (4.7 \times 10^3) \Rightarrow V_C = 2.25$

EXAMPLE 3



Compute $V_C, V_B, V_E, I_C, I_B, I_E$ assuming the BJT is in saturation mode

---

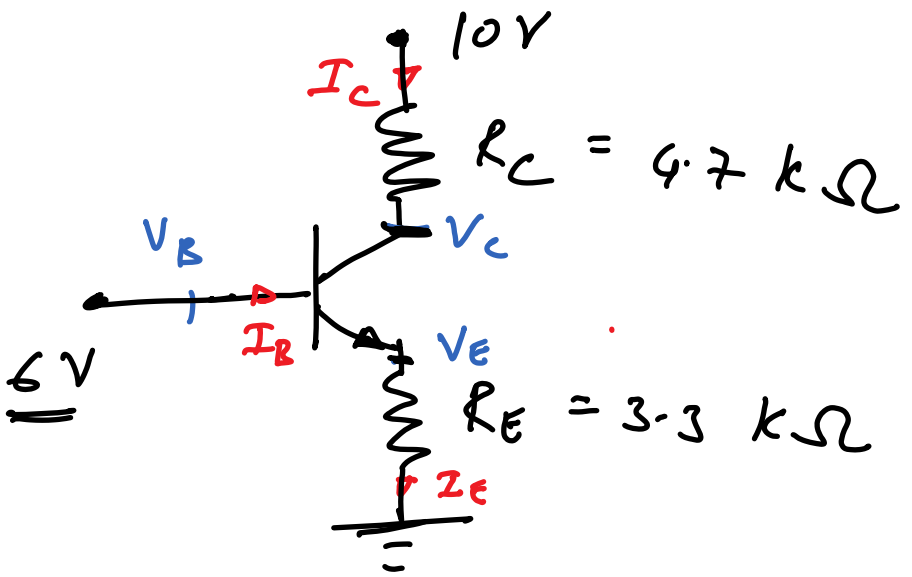
In saturation mode

$I_B, I_C > 0$

$V_{BE} \geq 0.7$

$V_{CE} \simeq 0.2$

$I_C \neq \beta I_B$



$V_B, V_C, V_E, I_C, I_B, I_E$

$10 - V_C = I_C R_C$ — (1)

$6 - V_B = 0$ — (2)

$V_E - 0 = I_E R_E$ — (3)

$V_{BE} = V_B - V_E = 0.7$ — (4)

$V_{CE} = V_C - V_E = 0.2$ — (5)

$I_C = I_B + I_E$ — (6)

$V_E = 5.3\ V$

$V_C = 5.5\ V$

$V_B = 6\ V$

$I_E = 1.6\ mA$

$I_B = 0.64\ mA$

$I_C = 0.96\ mA$

$\Rightarrow \quad \frac{I_C}{I_B} = \frac{0.96}{0.64} = 1.5$ (not 100)

Saturation mode $\neq \beta$