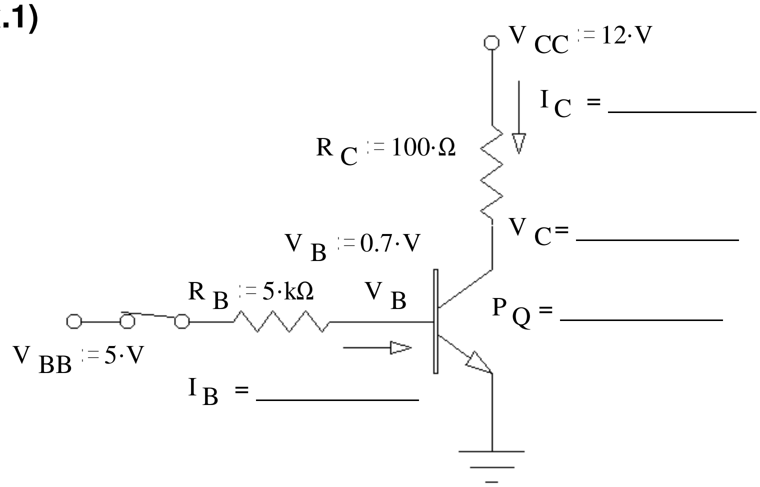
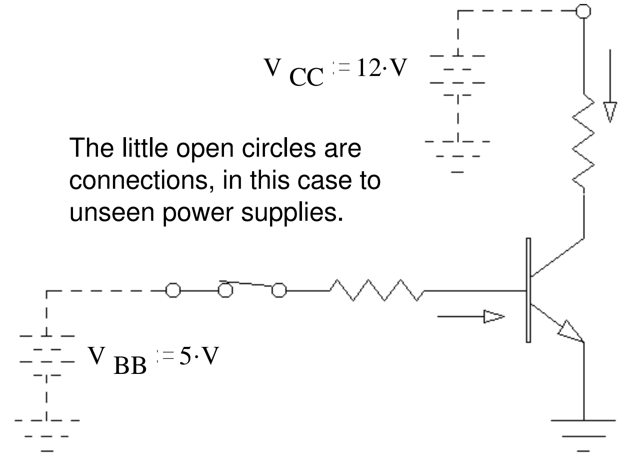
Ex.1)





If: $\beta := 100$	$I_B := \dfrac{V_{BB} - 0.7 \cdot V}{R_B}$	$I_B = 0.86 \cdot mA$	$I_C := \beta \cdot I_B$	$I_C = 86 \cdot mA$
			$V_C := V_{CC} - R_C \cdot I_C$	$V_C = 3.4 \cdot V$
			$P_Q := V_C \cdot I_C$	$P_Q = 292.4 \cdot mW$
If: $\beta := 200$	$I_B := \dfrac{V_{BB} - 0.7 \cdot V}{R_B}$	$I_B = 0.86 \cdot mA$	$I_C := \beta \cdot I_B$	$I_C = 172 \cdot mA$
			$V_C := V_{CC} - R_C \cdot I_C$	$V_C = -5.2 \cdot V$
			must be in saturation:	$V_C := 0.2 \cdot V$
			$I_C := \dfrac{V_{CC} - V_C}{R_C}$	$I_C = 118 \cdot mA$
			$P_Q := V_C \cdot I_C$	$P_Q = 23.6 \cdot mW$

Since saturation can depend on β, You usually assume a small β when designing a circuit that should saturate (a switching circuit).

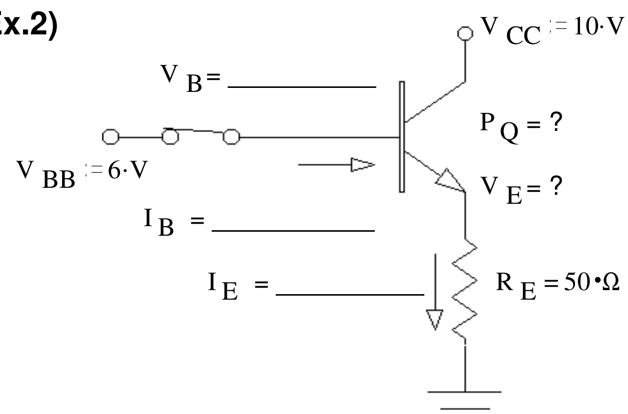
If: $R_C := 50 \cdot \Omega$	$I_C := \beta \cdot I_B$	$I_C = 172 \cdot mA$	$V_C := V_{CC} - R_C \cdot I_C$	$V_C = 3.4 \cdot V$
same $\beta := 200$			$P_Q := V_C \cdot I_C$	$P_Q = 584.8 \cdot mW$

Saturation also depends on R_C and V_{CC}.

What is the largest value that R_B could be and still keep the transistor in saturation?

$$I_{Csat} := \frac{V_{CC} - 0.2 \cdot V}{R_C} \qquad I_{Csat} = 236 \cdot mA \qquad I_B := \frac{I_{Csat}}{\beta} \qquad I_B = 1.2 \cdot mA \qquad R_{Bmax} = \frac{5 \cdot V - 0.7 \cdot V}{I_B} = 4 \cdot k\Omega$$

Ex.2)



$V_B := 6 \cdot V \qquad V_E := 5.3 \cdot V \qquad R_E := 50 \cdot \Omega$

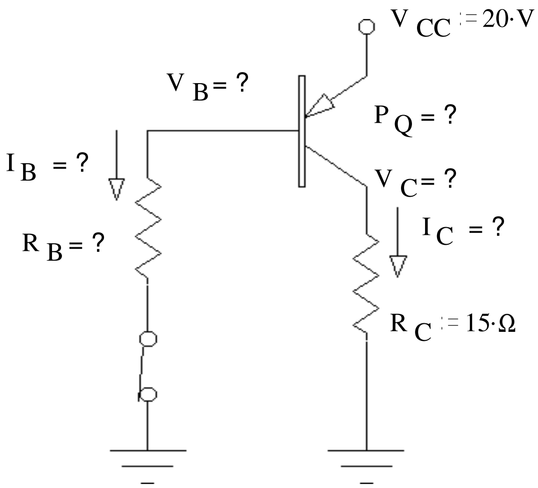
$$I_E := \frac{V_E}{R_E} \qquad I_E = 106 \cdot mA$$

$$I_B := \frac{I_E}{\beta + 1} \qquad I_B = 0.5 \cdot mA$$

Almost independent of β, if β is big enough.

$$P_Q := (V_{CC} - V_E) \cdot I_E \qquad P_Q = 0.498 \cdot W$$

Ex.3) Let's assume a small β. $\beta := 10$ Let's assume saturation and find the R_B necessary.



$V_C := V_{CC} - 0.2\cdot V$ $\quad V_C = 19.8\cdot V$

$R_C := 15\cdot\Omega$

$I_{Csat} := \dfrac{V_C}{R_C}$ $\quad I_{Csat} = 1.32\cdot A$

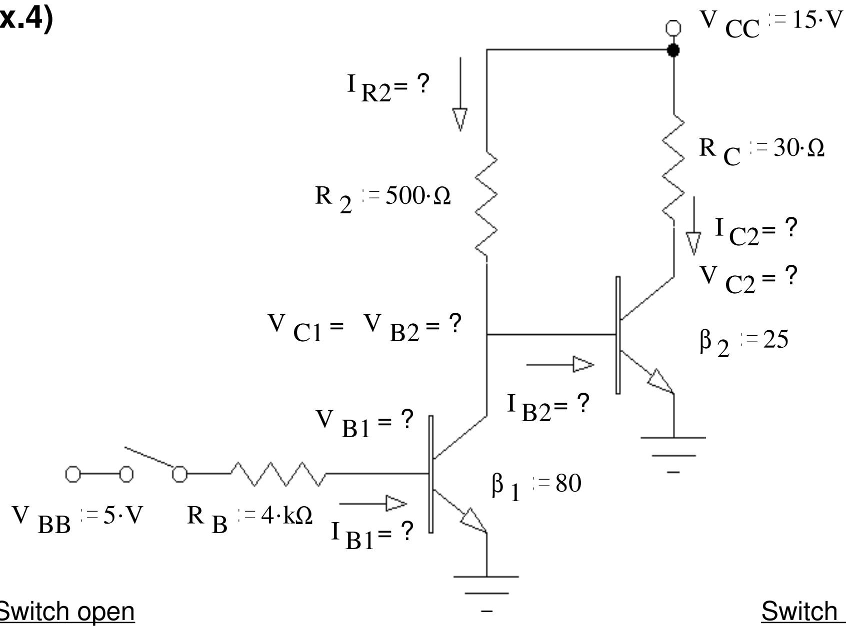
$I_B := \dfrac{I_{Csat}}{\beta}$ $\quad I_B = 132\cdot mA$

$V_B := V_{CC} - 0.7\cdot V$ $\quad V_B = 19.3\cdot V$

$R_B := \dfrac{V_B}{I_B}$ $\quad R_B = 146\cdot\Omega$

$P_Q := 0.2\cdot V\cdot I_C$ $\quad P_Q = 34\cdot mW$

Ex.4)



Switch open

$I_{B1o} := 0$ $\quad V_{B1o} := 0\cdot V$

$V_{B2o} := 0.7\cdot V$

$I_{B2o} := \dfrac{V_{CC} - 0.7\cdot V}{R_2}$ $\quad I_{B2o} = 28.6\cdot mA$

$I_{R2o} := I_{B2o}$ $\quad I_{R2o} = 28.6\cdot mA$

$I_{C2o} := \beta_2\cdot I_{B2o}$ $\quad I_{C2o} = 715\cdot mA$

$V_{C2o} := V_{CC} - R_C\cdot I_{C2o}$ $\quad V_{C2o} = -6.45\cdot V$

Q_2 must be in saturation: $\quad V_{C2o} := 0.2\cdot V$

$I_{C2o} := \dfrac{V_{CC} - V_{C2o}}{R_C}$ $\quad I_{C2o} = 493.3\cdot mA$

Switch closed

$I_{B1c} := \dfrac{5\cdot V - 0.7\cdot V}{R_B}$ $\quad I_{B1c} = 1.08\cdot mA$

assume Q_1 is in saturation $\quad V_{C1c} := 0.2\cdot V$

$I_{C1c} := \dfrac{V_{CC} - V_{C1c}}{R_2}$ $\quad I_{C1c} = 29.6\cdot mA$

$\beta_1\cdot I_{B1c} = 86\cdot mA$ $\quad I_{C1}$ is controlled by R_2

$V_{B2c} := V_{C1c}$ $\quad V_{B2c} = 0.2\cdot V$

$I_{B2c} := 0$ $\quad I_{C2c} := 0 \quad = \quad I_{RCc}$

When the switch is open, current flows in through the load resistor, R_C, When it is closed, no current flows though the load. This is an example of logical "inversion".