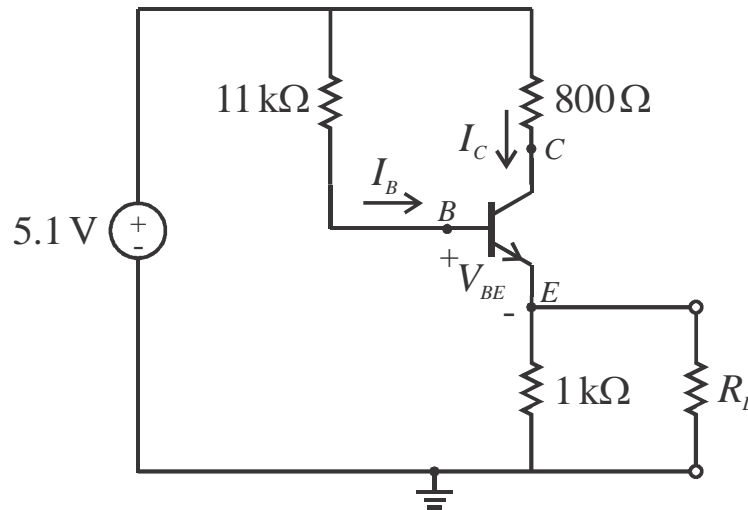
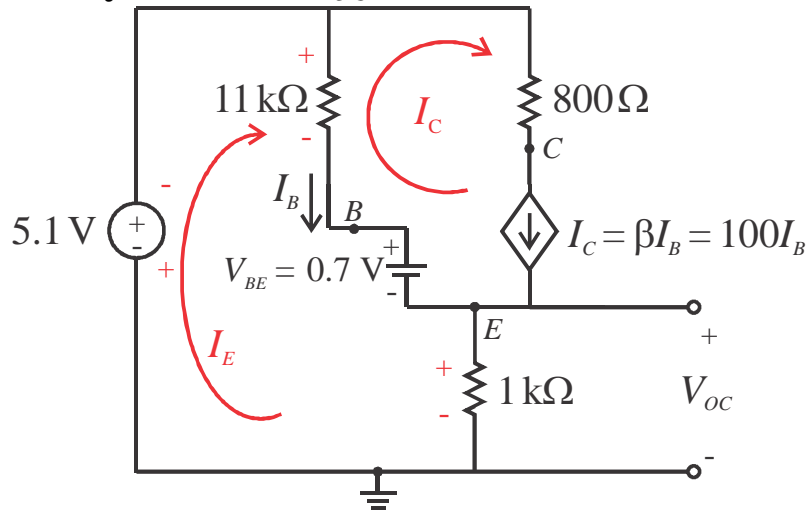


Example- Find the Thevenin equivalent circuit 'seen' by the load resistor R_L when the npn BJT has $V_{BE} = 0.7 \text{ V}$ and $\beta = 100$.



Find Thevenin voltage V_T

- Remove R_L and assign V_{OC} as open circuit voltage.
- Replace BJT with equivalent circuit model.
- Apply **mesh analysis** to find V_{OC} .



Collector mesh: $I_C = \beta I_B = 100 I_B = 100 (I_E - I_C)$

Emitter mesh: $-5.1 \text{ V} + (I_E - I_C)11000 + 0.7 \text{ V} + (I_E)1000 = 0$

Put equations in standard form- $[100] I_E + [-100 - 1] I_C = 0$

$$[11000 + 1000] I_E + [-11000] I_C = 5.1 - 0.7$$

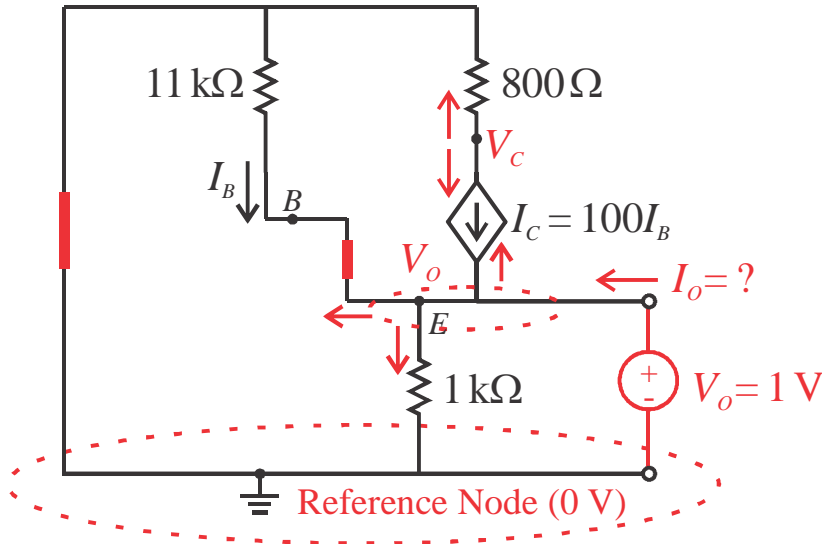
Solve for mesh currents- $I_E = \mathbf{3.96786 \text{ mA}}$ and $I_C = \mathbf{3.92857 \text{ mA}}$

Use Ohm's Law to find open circuit voltage- $V_{OC} = V_{1k\Omega} = I_E (1000) = 3.96786 \text{ V}$

$$V_{OC} = \mathbf{V_T = 3.968 \text{ V}}$$

Find Thevenin resistance R_T

- Replace BJT with equivalent circuit model.
- Set independent sources to zero, e.g., $5.1 \text{ V} \rightarrow 0 \text{ V}$ and $V_{BE} \rightarrow 0 \text{ V}$.
- Remove R_L and replace with an independent output voltage $V_O = 1 \text{ V}$.
- Apply **nodal analysis** & KCL to find I_O and hence $R_T = V_O / I_O$.



Output node: $V_O = 1 \text{ V}$ and **Collector node:** $\frac{V_C - 0}{800} + 100I_B = 0$ (not needed)

Apply KCL at output node: $I_O = \frac{V_O - 0}{1000} - I_B - 100I_B$

where, by Ohm's Law, $I_B = \frac{0 - V_O}{11000} = \frac{-1}{11000} = -90.90 \bar{9} \mu\text{A}$

substitute in I_B and solve for I_O : $I_O = \frac{1}{1000} - \left(\frac{-1}{11000}\right) - 100\left(\frac{-1}{11000}\right) = 0.01018 \bar{8} \text{ A}$

Finally, find Thevenin resistance - $R_T = \frac{V_O}{I_O} = \frac{1}{0.01018} \Rightarrow \underline{\underline{R_T = 98.214 \Omega}}$

Thevenin Equivalent Circuit-

