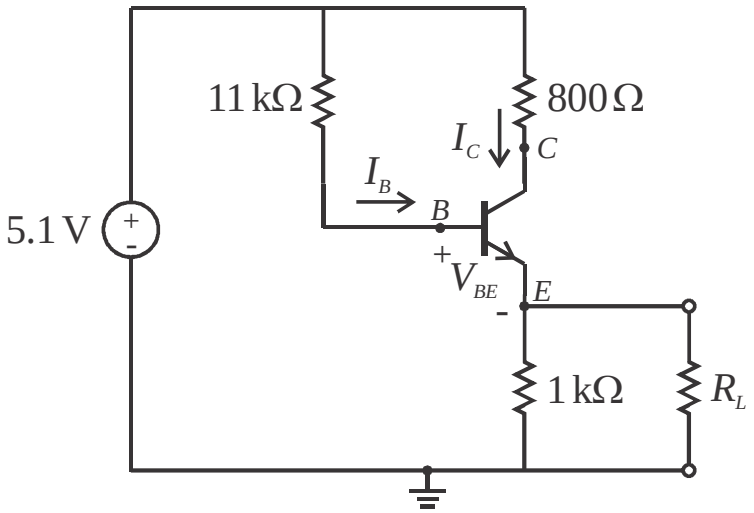
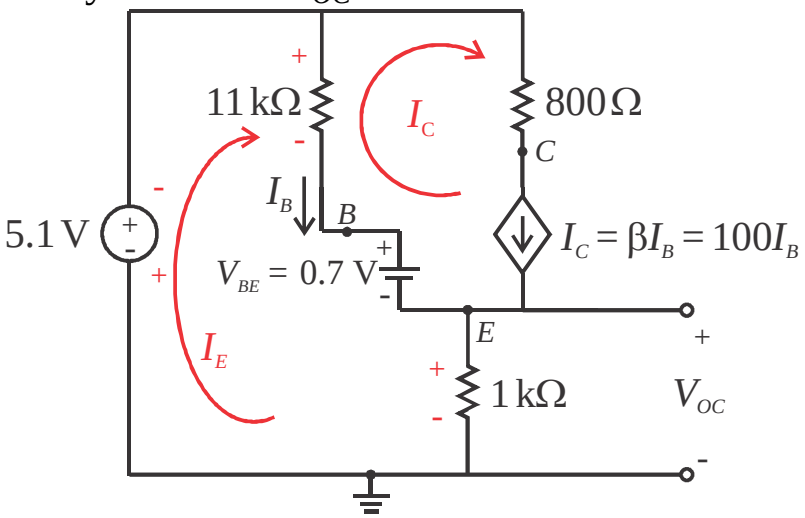
Example- Find the Thevenin equivalent circuit 'seen' by the load resistor R_L when the npn BJT has V_{BE} = 0.7 V and β = 100.



Find Thevenin voltage V_T

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



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

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

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

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

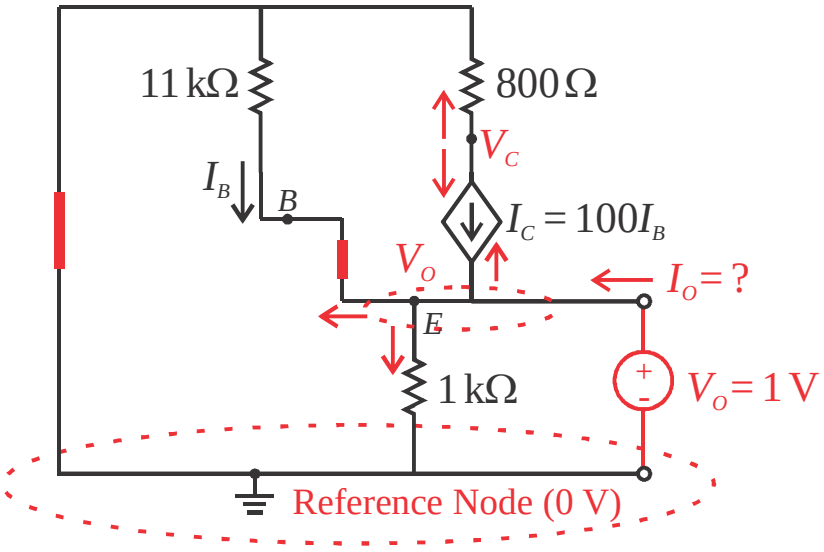
Solve for mesh currents- $\boldsymbol{I_E = 3.96786\text{ mA}}$ and $\boldsymbol{I_C = 3.92857\text{ mA}}$

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

$V_{OC} = \underline{\boldsymbol{V_T = 3.968\text{ V}}}$

Find Thevenin resistance R_T

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



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

by Ohm's Law $I_B = \frac{0 - V_O}{11000} = \frac{-1}{11000} = -90.\overline{90}\ \mu A$

Apply KCL at output node:

$$I_O = \frac{V_O - 0}{1000} - I_B - 100 I_B$$

$$= \frac{1}{1000} - \left(\frac{-1}{11000}\right) - 100\left(\frac{-1}{11000}\right) = 0.01\overline{018}\ \text{A}$$

Use Ohm's Law to find Thevenin resistance - $R_T = \frac{V_O}{I_O} = \frac{1}{0.01\overline{018}} = \underline{98.214\ \Omega}$

Thevenin Equivalent Circuit-