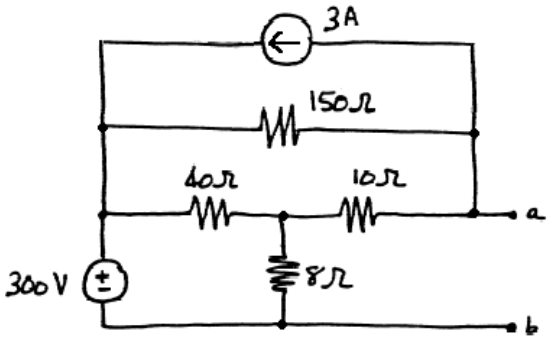
EECE499 - HOMEWORK #3

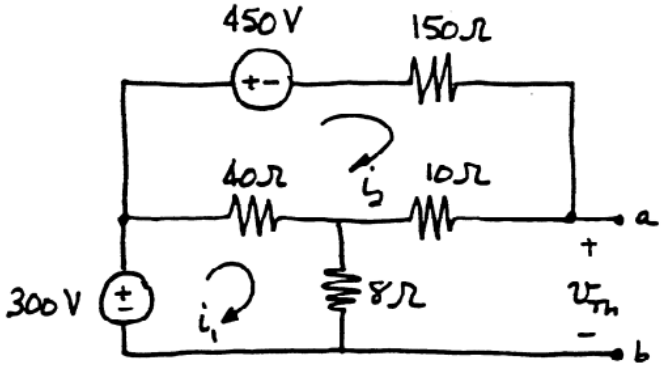
Due (F) Feb 25

SOLUTION

1. (Problem 4.61) Find the Thevenin equivalent with respect to the terminals *a* and *b* for the circuit below.



SOL)



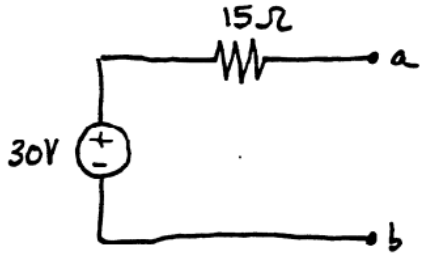
$$300 = 48i_1 - 40i_2$$

$$-450 = -40i_1 + 200i_2$$

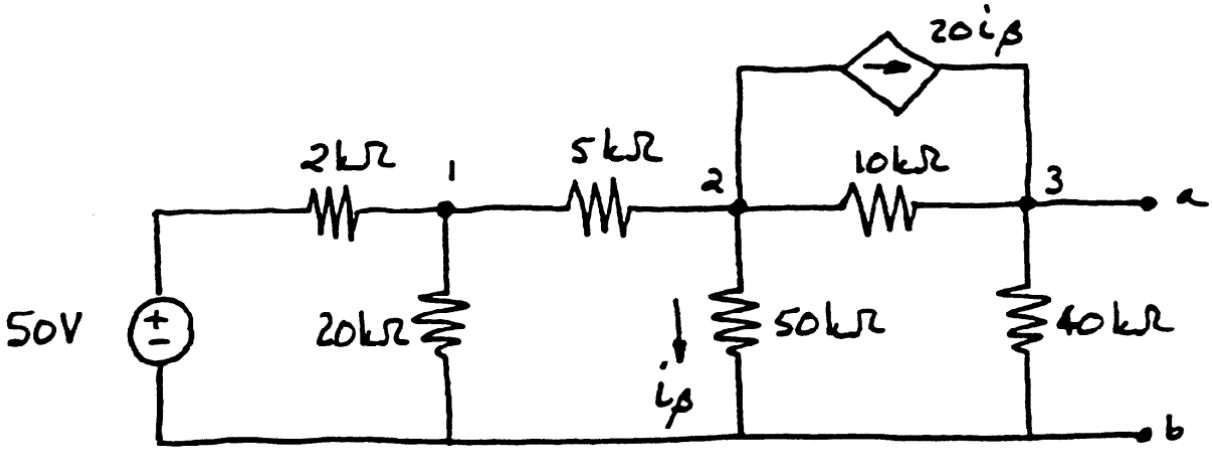
$$\therefore \quad i_1 = 5.25 \text{ A and } i_2 = -1.2 \text{ A}$$

$$v_{Th} = 8i_1 + 10i_2 = 30 \text{ V}$$

$$R_{Th} = (40 \| 8 + 10) \| 50 = 15\,\Omega$$



2. (Problem 4.66) Find the Thevenin equivalent with respect to the terminals *a* and *b* for the circuit below.



SOL)

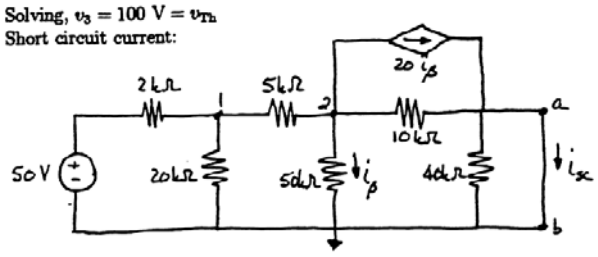
$$\frac{v_1 - 50}{2} + \frac{v_1}{20} + \frac{v_1 - v_2}{5} = 0$$

$$\frac{v_2 - v_1}{5} + \frac{v_2}{50} + \frac{v_2 - v_3}{10} + 20\frac{v_2}{50} = 0$$

$$\frac{v_3}{40} + \frac{v_3 - v_2}{10} - 20\frac{v_2}{50} = 0$$

Solving, $v_3 = 100\ \text{V} = v_{\text{Th}}$

Short circuit current:



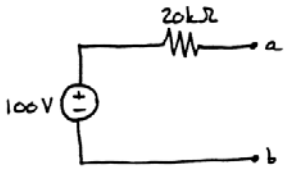
$$\frac{v_1}{20} + \frac{v_1 - 50}{2} + \frac{v_1 - v_2}{5} = 0$$

$$\frac{v_2 - v_1}{5} + \frac{v_2}{50} + \frac{v_2}{10} + 20\frac{v_2}{50} = 0$$

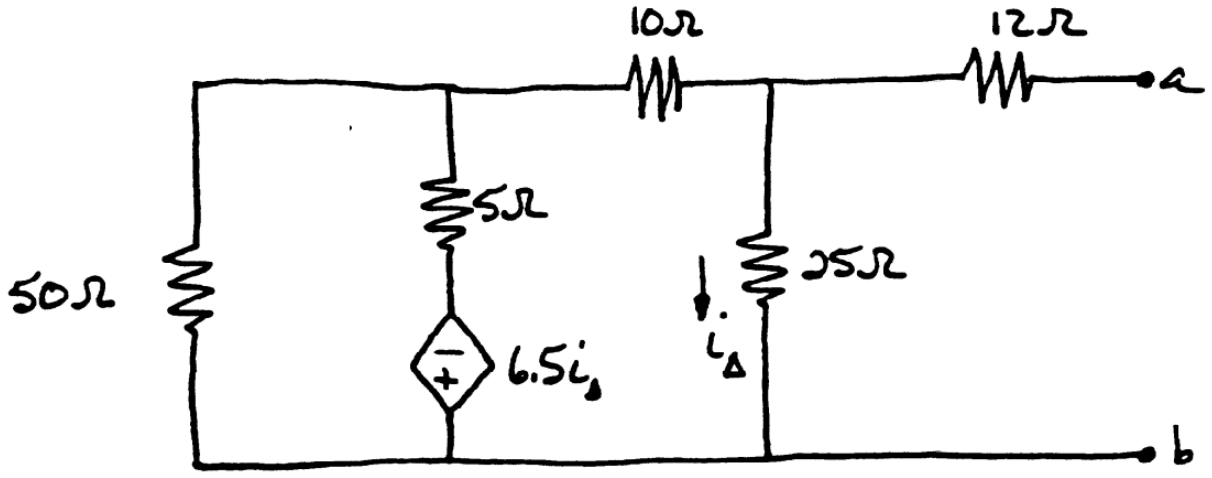
Solving, $v_2 = 10\ \text{V}$

$$i_{sc} = \frac{20(10)}{50} + \frac{10}{10} = 4 + 1 = 5\ \text{mA}$$

$$\therefore\ R_{\text{Th}} = \frac{v_{\text{Th}}}{i_{sc}} = 100/5 = 20\ \text{k}\Omega$$

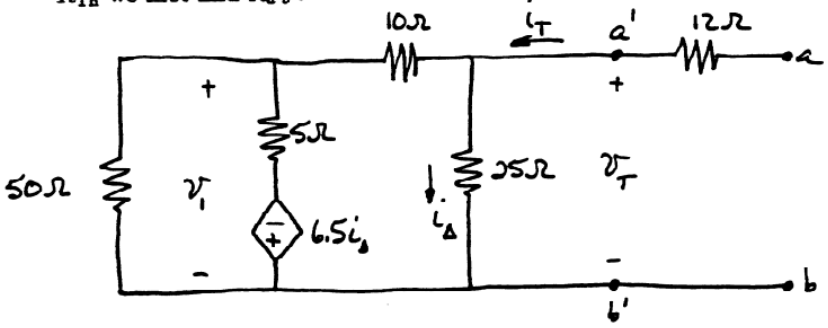


3. (Problem 4.70) Find the Thevenin equivalent with respect to the terminals *a* and *b* for the circuit below.



SOL)

P 4.70 $V_{Th} = 0$ since there are no independent sources in the circuit. To find R_{Th} we first find $R_{a'b'}$.



$$i_T = \frac{v_T}{25} + \frac{v_T - v_1}{10}$$

$$\frac{v_1}{50} + \frac{v_1 + 6.5i_\Delta}{5} + \frac{v_1 - v_T}{10} = 0 \text{ so } 16v_1 + 65i_\Delta = 5v_T$$

$$i_\Delta = \frac{v_T}{25}, \qquad 65i_\Delta = 2.6v_T$$

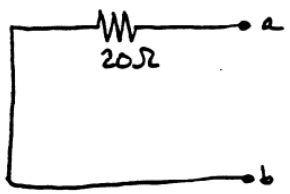
$$16v_1 + 2.6v_T = 5v_T$$

$$\therefore \quad v_1 = 0.15v_T$$

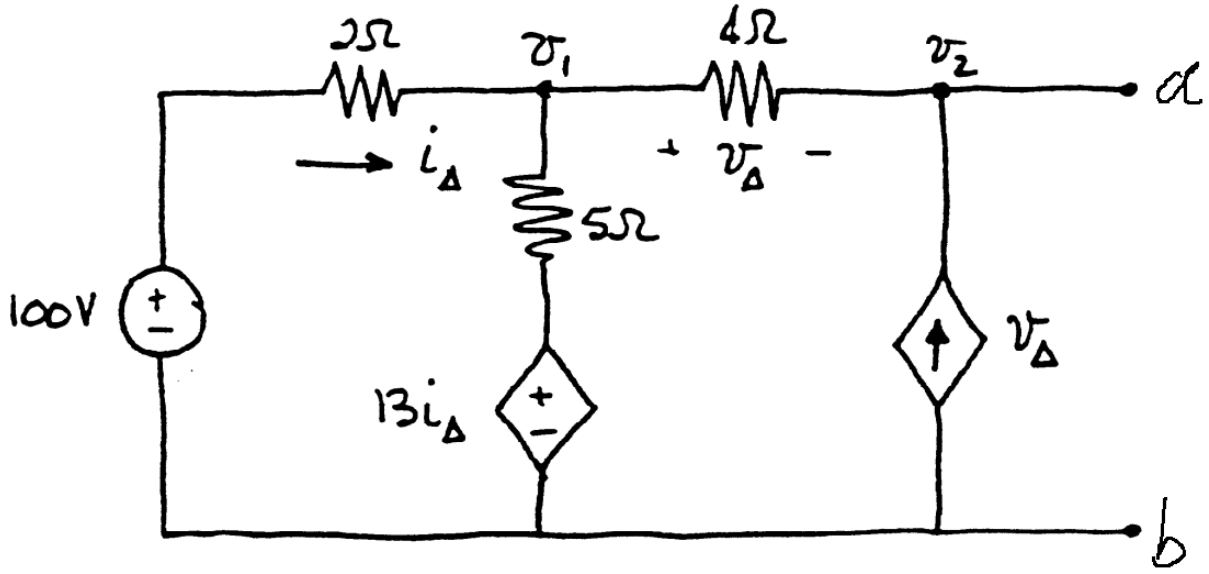
$$i_T = \frac{v_T}{25} + \frac{v_T - 0.15v_T}{10} = \frac{6.25}{50}v_T$$

$$\frac{v_T}{i_T} = 50/6.25 = 8\,\Omega = R_{a'b'}$$

$$\therefore \quad R_{Th} = 12 + 8 = 20\,\Omega$$



4. (Problem 4. 81) Find the Thevenin equivalent with respect to the terminals *a* and *b* for the circuit below.



SOL)

Node voltage equation:

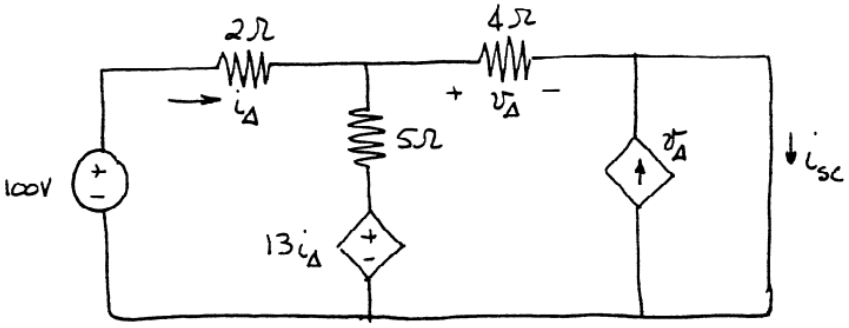
$$\frac{v_1 - 100}{2} + \frac{v_1 - 13i_\Delta}{5} + \frac{v_1 - v_2}{4} = 0$$

Constraint equations:

$$i_\Delta = \frac{100 - v_1}{2}; \qquad \frac{v_2 - v_1}{4} - v_\Delta = 0; \qquad v_\Delta = v_1 - v_2$$

Solving, $v_2 = 90\ \text{V} = v_{\text{Th}}$

Short circuit current:



$$\frac{v_1 - 100}{2} + \frac{v_1 - 13i_\Delta}{5} + \frac{v_1}{4} = 0$$

$$i_\Delta = \frac{100 - v_1}{2}$$

Solving, $v_1 = 80\ \text{V} = v_\Delta$

$$i_{sc} = \frac{v_1}{4} + v_\Delta = 20 + 80 = 100\ \text{A}$$

$$R_{\text{Th}} = \frac{v_{\text{Th}}}{i_{sc}} = \frac{90}{100} = 0.9\,\Omega$$

$$\therefore \quad R_o = R_{\text{Th}} = 0.9\,\Omega$$