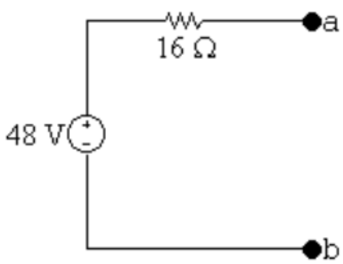
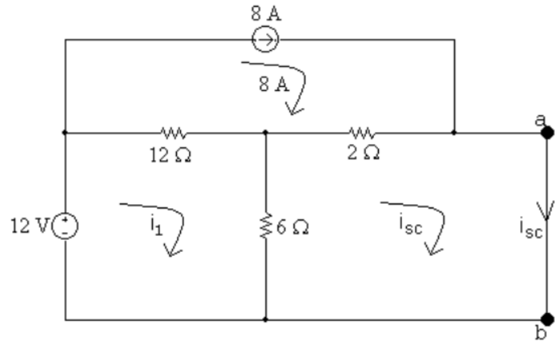
P 4.64 $v_{\text{Th}} = \dfrac{40}{50}(60) = 48\,\text{V};$

$$R_{\text{Th}} = 8 + 10\|40 = 16\,\Omega.$$



P 4.66

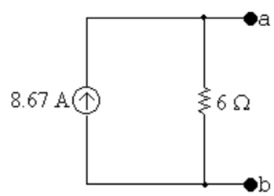


$$-12 + 12(i_1 - 8) + 6(i_1 - i_{\text{sc}}) = 0;$$

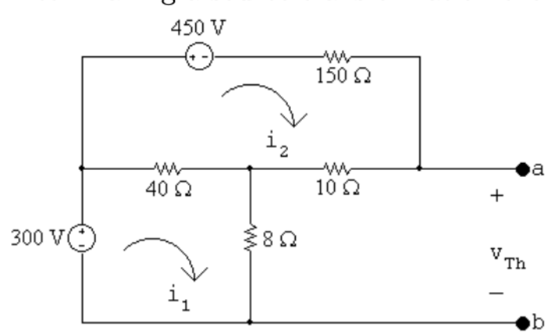
$$2(i_{\text{sc}} - 8) + 6(i_{\text{sc}} - i_1) = 0.$$

Solving, $\quad i_{\text{sc}} = 8.67\,\text{A};$

$$R_{\text{Th}} = 2 + 12\|6 = 6\,\Omega.$$



P 4.67 After making a source transformation the circuit becomes



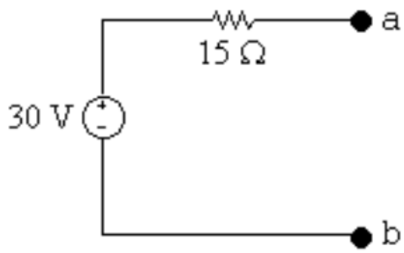
$$-300 + 40(i_1 - i_2) + 8i_1 = 0;$$

$$450 + 150i_2 + 10i_2 + 40(i_2 - i_1) = 0.$$

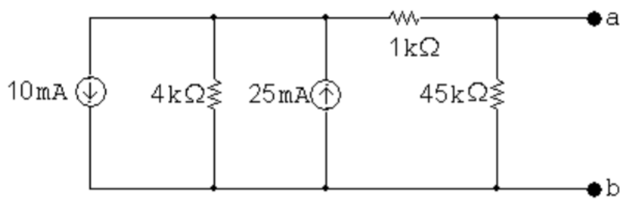
$$\therefore \quad i_1 = 5.25\,\text{A and } i_2 = -1.2\,\text{A}.$$

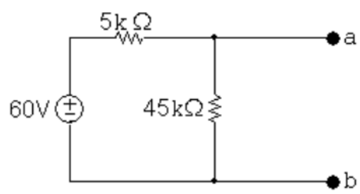
$$v_{\mathrm{Th}} = 10i_2 + 8i_1 = 30\,\mathrm{V};$$

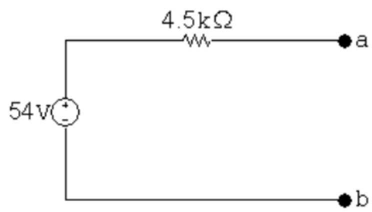
$$R_{\mathrm{Th}} = (40\|8 + 10)\|150 = 15\,\Omega.$$



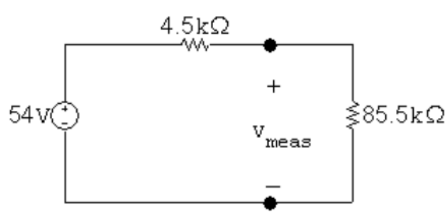
P 4.72 **[a]** First, find the Thévenin equivalent with respect to a,b using a succession of source transformations.







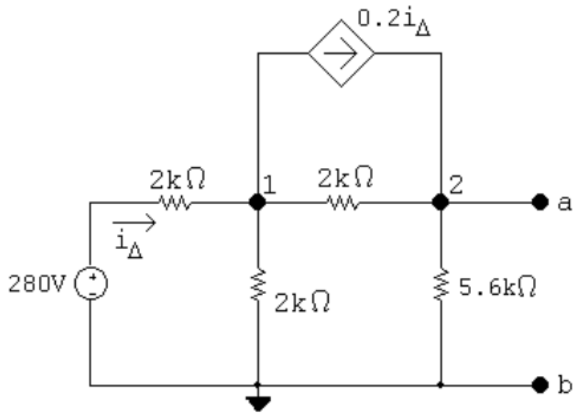
$$\therefore \quad v_{\text{Th}} = 54\,\text{V} \qquad R_{\text{Th}} = 4.5\,\text{k}\Omega.$$



$$v_{\text{meas}} = \frac{54}{90}(85.5) = 51.3\,\text{V}.$$

[b] $$\%\text{error} = \left(\frac{51.3 - 54}{54}\right) \times 100 = -5\%.$$

P 4.75



The node voltage equations and dependant source equation are:

$$\begin{aligned}
\frac{v_1 - 280}{2000} + \frac{v_1}{2000} + \frac{v_1 - v_2}{2000} + 0.2i_\Delta &= 0; \\
\frac{v_2 - v_1}{2000} + \frac{v_2}{5600} - 0.2i_\Delta &= 0; \\
i_\Delta &= \frac{280 - v_1}{2000}.
\end{aligned}$$

In standard form:

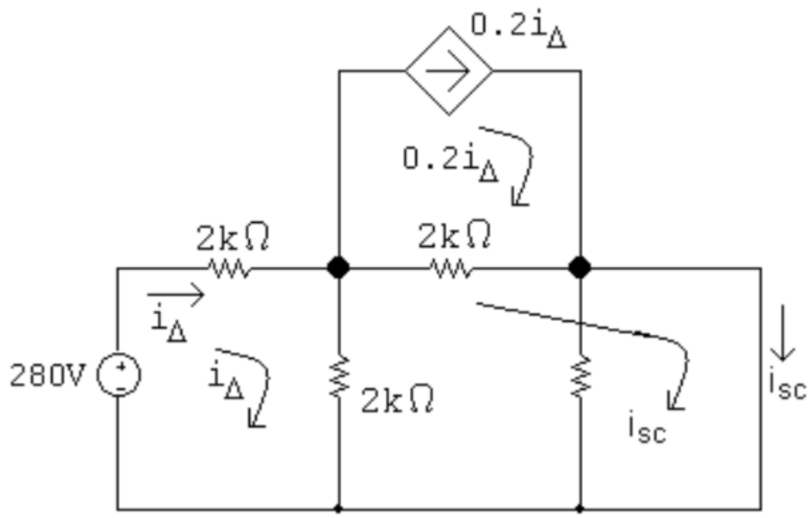
$$v_1\left(\frac{1}{2000} + \frac{1}{2000} + \frac{1}{2000}\right) + v_2\left(-\frac{1}{2000}\right) + i_\Delta(0.2) = \frac{280}{2000};$$

$$v_1\left(-\frac{1}{2000}\right) + v_2\left(\frac{1}{2000} + \frac{1}{5600}\right) + i_\Delta(-0.2) = 0;$$

$$v_1\left(\frac{1}{2000}\right) + v_2(0) + i_\Delta(1) = \frac{280}{2000}.$$

Solving, $\quad v_1 = 120\,\text{V}; \quad v_2 = 112\,\text{V}; \quad i_\Delta = 0.08\,\text{A}$

$V_{\text{Th}} = v_2 = 112\,\text{V}.$



The mesh current equations are:

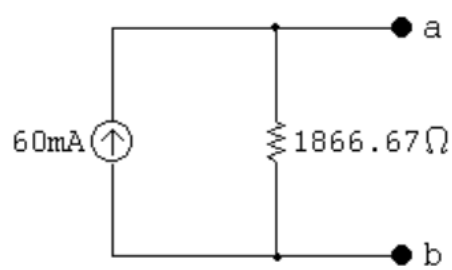
$$\begin{aligned} -280 + 2000i_\Delta + 2000(i_\Delta - i_{\text{sc}}) &= 0; \\ 2000(i_{\text{sc}} - 0.2i_\Delta) + 2000(i_{\text{sc}} - i_\Delta) &= 0. \end{aligned}$$

Put these equations in standard form:

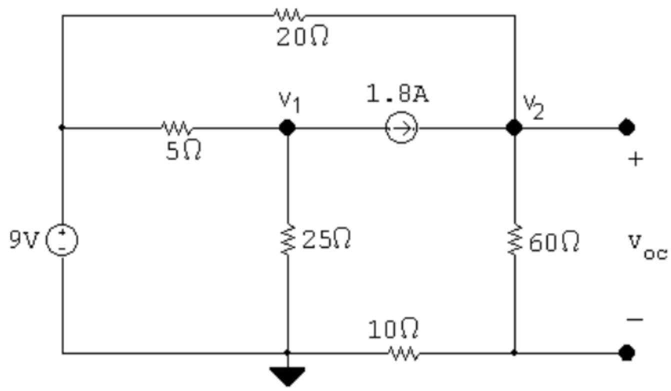
$$\begin{aligned} i_\Delta(4000) + i_{\text{sc}}(-2000) &= 280; \\ i_\Delta(-2400) + i_{\text{sc}}(4000) &= 0. \end{aligned}$$

Solving, $i_\Delta = 0.1\,\text{A}; \qquad i_{\text{sc}} = 0.06\,\text{A};$

$R_{\text{Th}} = \dfrac{112}{0.06} = 1866.67\,\Omega.$



P 4.78 **[a]** Open circuit:

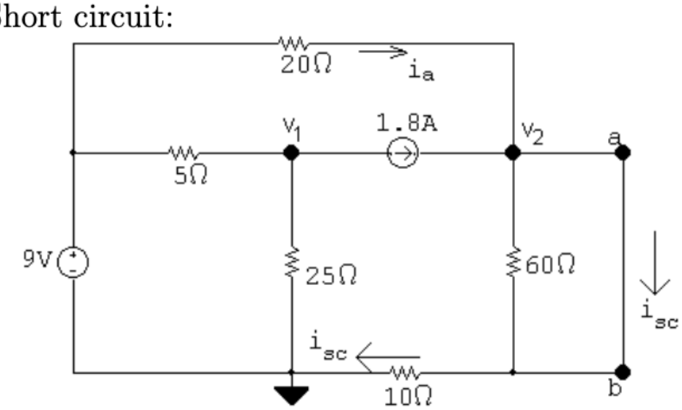


$$\frac{v_2 - 9}{20} + \frac{v_2}{70} - 1.8 = 0;$$

$$v_2 = 35\,\text{V};$$

$$v_{\text{Th}} = \frac{60}{70} v_2 = 30\,\text{V}.$$

Short circuit:



$$\frac{v_2 - 9}{20} + \frac{v_2}{10} - 1.8 = 0;$$

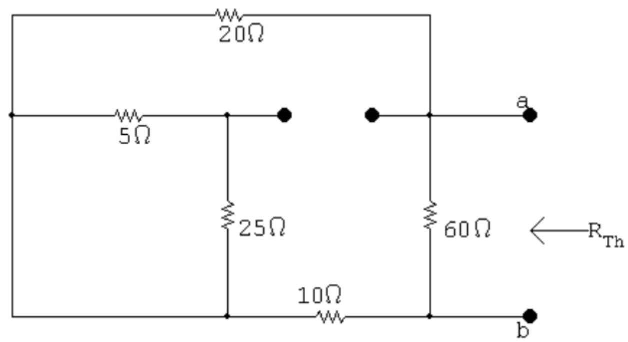
$$\therefore \quad v_2 = 15\,\text{V}.$$

$$i_{\text{a}} = \frac{9 - 15}{20} = -0.3\,\text{A};$$

$$i_{\text{sc}} = 1.8 - 0.3 = 1.5\,\text{A};$$

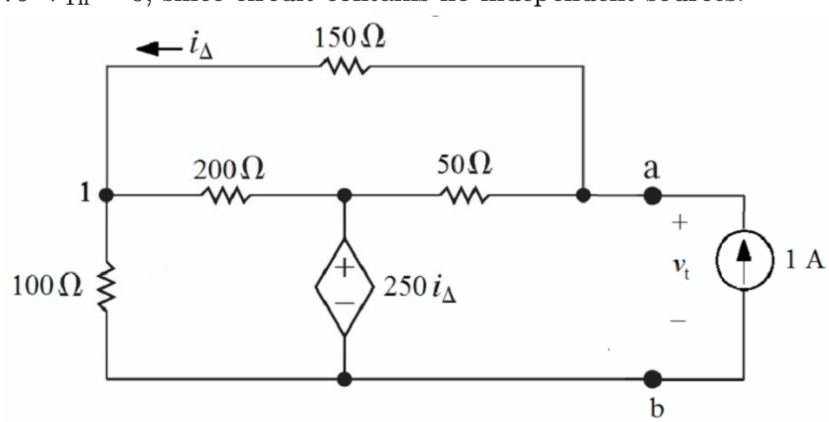
$$R_{\text{Th}} = \frac{30}{1.5} = 20\,\Omega.$$

[b]



$R_{\rm Th} = (20+10)\|60 = 20\,\Omega$ (CHECKS).

P 4.79 $V_{\rm Th} = 0$, since circuit contains no independent sources.



$$\frac{v_1}{100} + \frac{v_1 - 250i_\Delta}{200} + \frac{v_1 - v_{\rm t}}{150} = 0;$$

$$\frac{v_{\rm t} - v_1}{150} + \frac{v_{\rm t} - 250i_\Delta}{50} - 1 = 0;$$

$$i_\Delta = \frac{v_{\rm t} - v_1}{150}.$$

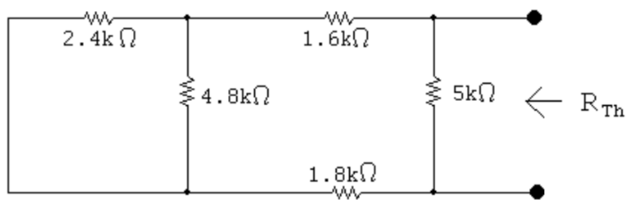
In standard form:

$$v_1\left(\frac{1}{100} + \frac{1}{200} + \frac{1}{150}\right) + v_{\rm t}\left(-\frac{1}{150}\right) + i_\Delta\left(-\frac{250}{200}\right) = 0;$$

$$v_1\left(-\frac{1}{150}\right) + v_{\rm t}\left(\frac{1}{150} + \frac{1}{50}\right) + i_\Delta\left(-\frac{250}{50}\right) = 1;$$

$$v_1\left(-\frac{1}{150}\right) + v_{\rm t}\left(\frac{1}{150}\right) + i_\Delta(-1) = 0.$$

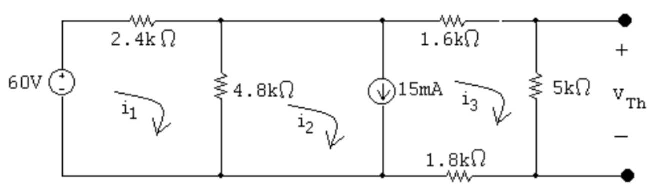
P 4.82 [a]



$$R_{\text{Th}} = 5000\|(1600 + 2400\|4800 + 1800) = 2.5\,\text{k}\Omega;$$

$R_o = R_{\text{Th}} = 2.5\,\text{k}\Omega.$

[b]



$7200i_1 - 4800i_2 = 60;$

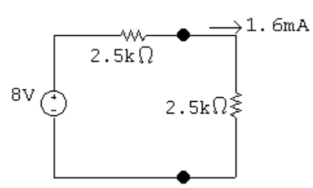
$-4800i_1 + 4800i_2 + 8400i_3 = 0;$

$i_2 - i_3 = 0.015.$

Solving,

$i_1 = 19.4\,\text{mA}; \qquad i_2 = 16.6\,\text{mA}; \qquad i_3 = 1.6\,\text{mA};$

$v_{\text{oc}} = 5000i_3 = 8\,\text{V}.$



$p_{\text{max}} = (1.6 \times 10^{-3})^2(2500) = 6.4\,\text{mW}.$

[c] The resistor closest to $2.5\,\text{k}\Omega$ from Appendix H has a value of $2.7\,\text{k}\Omega$. Use voltage division to find the voltage drop across this load resistor, and use the voltage to find the power delivered to it:

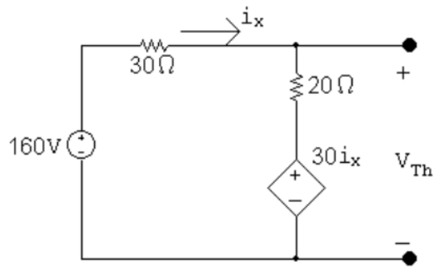
$$v_{2.7\text{k}} = \frac{2700}{2700 + 2500}(8) = 4.154\,\text{V};$$

$$p_{2.7\text{k}} = \frac{(4.154)^2}{2700} = 6.391\,\text{mW}.$$

The percent error between the maximum power and the power delivered to the best resistor from Appendix H is

$$\%\ \text{error} = \left(\frac{6.391}{6.4} - 1\right)(100) = -0.1\%.$$

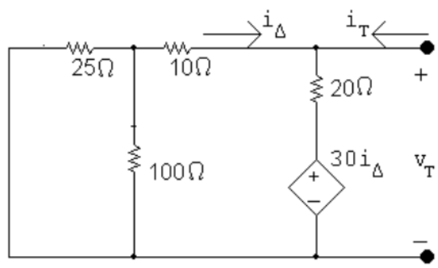
P 4.87 We begin by finding the Thévenin equivalent with respect to R_o. After making a couple of source transformations the circuit simplifies to



$$i_\Delta = \frac{160 - 30i_\Delta}{50}; \qquad i_\Delta = 2\,\text{A};$$

$V_{\mathrm{Th}} = 20i_\Delta + 30i_\Delta = 50i_\Delta = 100\,\mathrm{V}.$

Using the test-source method to find the Thévenin resistance gives

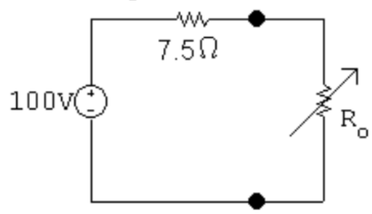


$$i_{\mathrm{T}} = \frac{v_{\mathrm{T}}}{30} + \frac{v_{\mathrm{T}} - 30(-v_{\mathrm{T}}/30)}{20};$$

$$\frac{i_{\mathrm{T}}}{v_{\mathrm{T}}} = \frac{1}{30} + \frac{1}{10} = \frac{4}{30} = \frac{2}{15};$$

$$R_{\mathrm{Th}} = \frac{v_{\mathrm{T}}}{i_{\mathrm{T}}} = \frac{15}{2} = 7.5\,\Omega.$$

Thus our problem is reduced to analyzing the circuit shown below:



$$p = \left(\frac{100}{7.5 + R_o}\right)^2 R_o = 250;$$

$$\frac{10^4}{R_o^2 + 15R_o + 56.25} R_o = 250;$$

$$\frac{10^4 R_o}{250} = R_o^2 + 15R_o + 56.25;$$

$$40R_o = R_o^2 + 15R_o + 56.25;$$

$$R_o^2 - 25R_o + 56.25 = 0;$$

$$R_o = 12.5 \pm \sqrt{156.25 - 56.25} = 12.5 \pm 10;$$

$$R_o = 22.5\,\Omega;$$

$$R_o = 2.5\,\Omega.$$