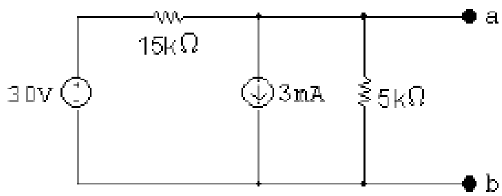
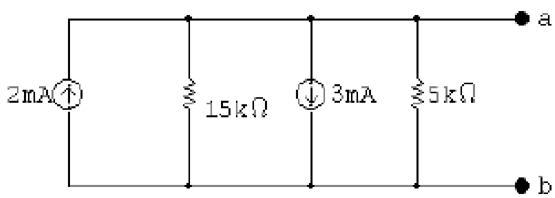
EENG 281 Homework #4 Solutions
Fall 2013

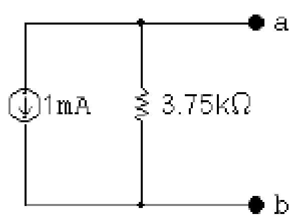
P 4.64 First we make the observation that the 10 mA current source and the 10 kΩ resistor will have no influence on the behavior of the circuit with respect to the terminals a,b. This follows because they are in parallel with an ideal voltage source. Hence our circuit can be simplified to



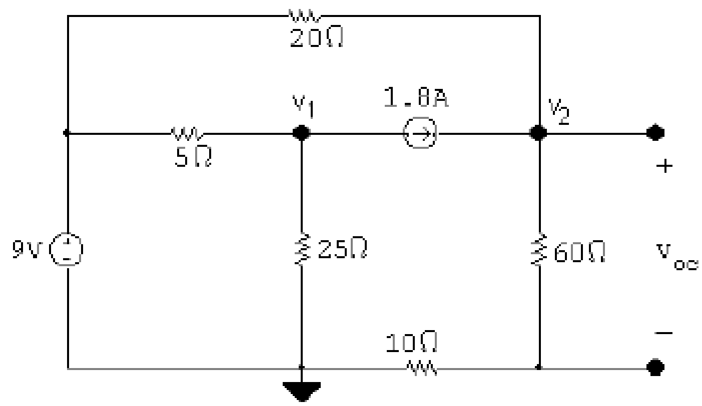
or



Therefore the Norton equivalent is



P 4.65 [a] Open circuit:

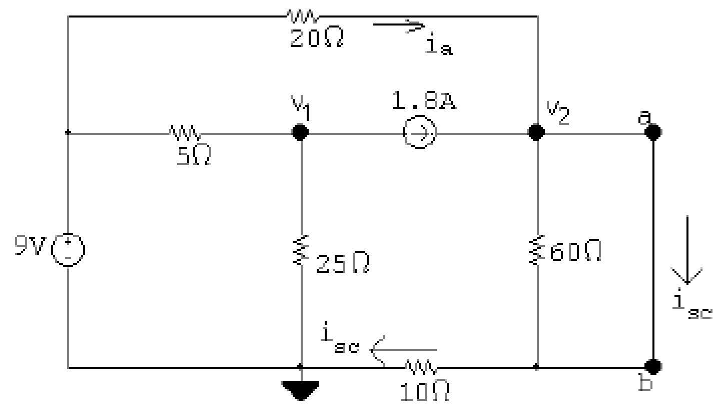


$$\frac{v_2 - 9}{20} + \frac{v_2}{70} - 1.8 = 0$$

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

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

Short circuit:



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

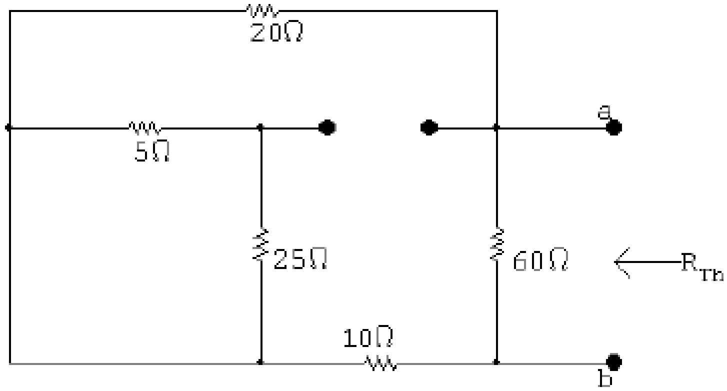
$$\therefore \quad v_2 = 15 \text{ V}$$

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

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

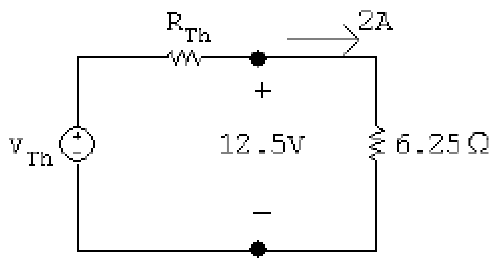
$$R_{\text{Th}} = \frac{30}{1.5} = 20\,\Omega$$

[b]

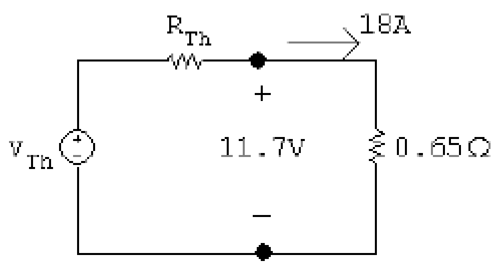


$R_{\mathrm{Th}} = (20 + 10\|60 = 20\,\Omega$ (CHECKS)

P 4.69



$12.5 = v_{\mathrm{Th}} - 2R_{\mathrm{Th}}$



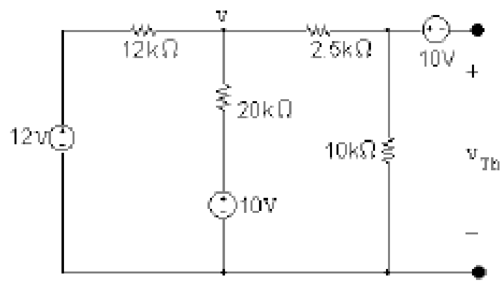
$11.7 = v_{\mathrm{Th}} - 18R_{\mathrm{Th}}$

Solving the above equations for V_{Th} and R_{Th} yields

$v_{\mathrm{Th}} = 12.6$ V, $\qquad R_{\mathrm{Th}} = 50$ mΩ

$\therefore \quad I_N = 252$ A, $\qquad R_N = 50$ mΩ

P 4.79 [a]

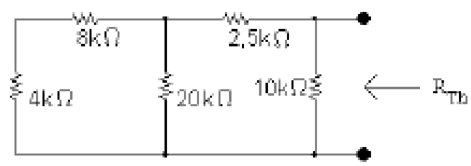


$$\frac{v-12}{12{,}000} + \frac{v-10}{20{,}000} + \frac{v}{12{,}500} = 0$$

Solving, $v = 7.03125$ V

$$v_{10k} = \frac{10{,}000}{12{,}500}(7.03125) = 5.625 \text{ V}$$

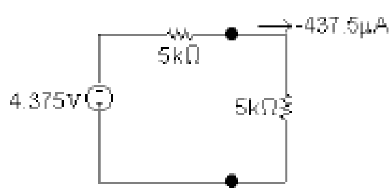
$$\therefore \quad V_{Th} = v - 10 = -4.375 \text{ V}$$



$$R_{Th} = [(12{,}000\|20{,}000) + 2500] = 5 \text{ k}\Omega$$

$$R_o = R_{Th} = 5 \text{ k}\Omega$$

[b]



$$p_{max} = (-437.5 \times 10^{-6})^2(5000) = 957\,\mu\text{W}$$

[c] The resistor closest to 5 kΩ from Appendix H has a value of 4.7 kΩ. Use voltage division to find the voltage drop across this load resistor, and use the voltage to find the power delivered to it:

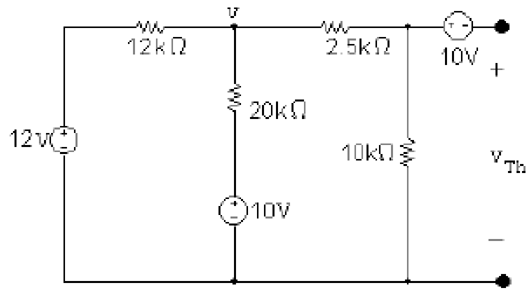
$$v_{4.7k} = \frac{4700}{4700+5000}(-4.375) = -2.12 \text{ V}$$

$$p_{4.7k} = \frac{(-2.12)^2}{4700} = 956.12\,\mu\text{W}$$

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

$$\%\ \text{error} = \left(\frac{956}{957} - 1\right)(100) = -0.1\%$$

P 4.79 [a]

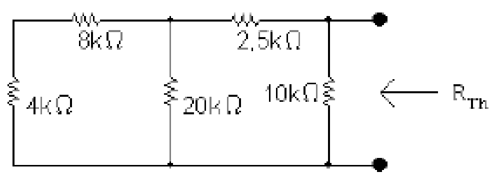


$$\frac{v-12}{12{,}000}+\frac{v-10}{20{,}000}+\frac{v}{12{,}500}=0$$

Solving, $\quad v = 7.03125$ V

$$v_{10\text{k}} = \frac{10{,}000}{12{,}500}(7.03125) = 5.625 \text{ V}$$

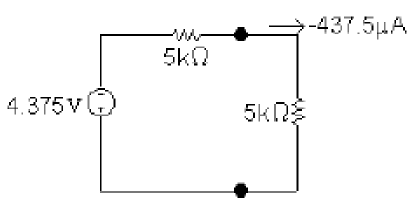
$$\therefore \quad V_{\text{Th}} = v - 10 = -4.375 \text{ V}$$



$$R_{\text{Th}} = [(12{,}000\|20{,}000) + 2500] = 5 \text{ k}\Omega$$

$$R_o = R_{\text{Th}} = 5 \text{ k}\Omega$$

[b]



$$p_{\text{max}} = (-437.5\times 10^{-6})^2(5000) = 957\,\mu\text{W}$$

[c] The resistor closest to 5 kΩ from Appendix H has a value of 4.7 kΩ. Use voltage division to find the voltage drop across this load resistor, and use the voltage to find the power delivered to it:

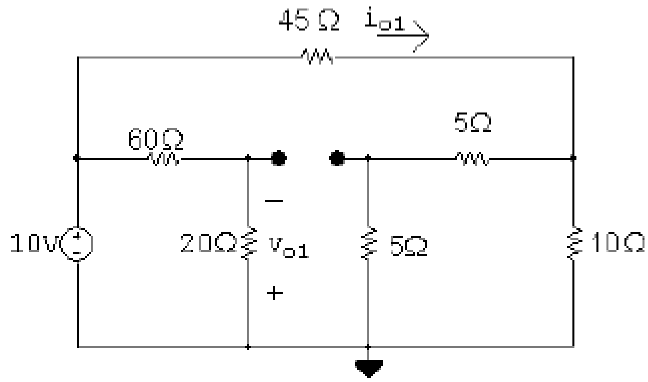
$$v_{4.7\text{k}} = \frac{4700}{4700+5000}(-4.375) = -2.12 \text{ V}$$

$$p_{4.7\text{k}} = \frac{(-2.12)^2}{4700} = 956.12\,\mu\text{W}$$

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

$$\%\text{ error} = \left(\frac{956}{957}-1\right)(100) = -0.1\%$$

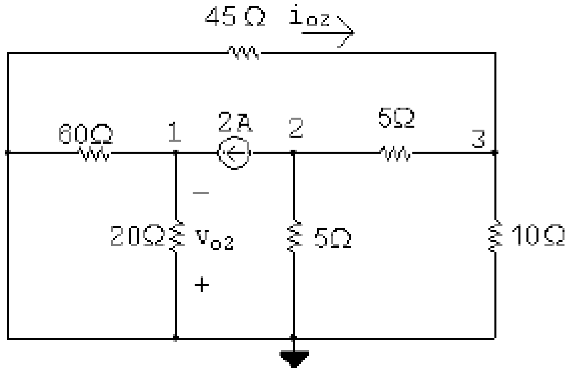
P 4.92 Voltage source acting alone:



$$i_{o1} = \frac{10}{45 + (5+5)\|10} = \frac{10}{45+5} = 0.2 \text{ A}$$

$$v_{o1} = \frac{20}{20+60}(-10) = -2.5 \text{ V}$$

Current source acting alone:



$$\frac{v_2}{5} + 2 + \frac{v_2 - v_3}{5} = 0$$

$$\frac{v_3}{10} + \frac{v_3 - v_2}{5} + \frac{v_3}{45} = 0$$

Solving, $v_2 = -7.25 \text{ V} = v_{o2}; \qquad v_3 = -4.5 \text{ V}$

$$i_{o2} = -\frac{v_3}{45} = -0.1 \text{ A}$$

$$i_{20} = \frac{60\|20}{20}(2) = 1.5 \text{ A}$$

$$v_{o2} = -20i_{20} = -20(1.5) = -30 \text{ V}$$

$$\therefore \quad v_o = v_{o1} + v_{o2} = -2.5 - 30 = -32.5 \text{ V}$$

$$i_o = i_{o1} + i_{o2} = 0.2 + 0.1 = 0.3 \text{ A}$$