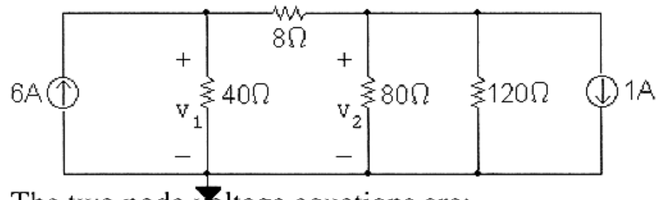
ENSC 220 – Assignment #2 Solutions (2004)

P 4.9



The two node voltage equations are:

$$-6+\frac{v_1}{40}+\frac{v_1-v_2}{8} = 0$$

$$\frac{v_2-v_1}{8}+\frac{v_2}{80}+\frac{v_2}{120}+1 = 0$$

Place these equations in standard form:

$$v_1\left(\frac{1}{40}+\frac{1}{8}\right) + v_2\left(-\frac{1}{8}\right) = 6$$

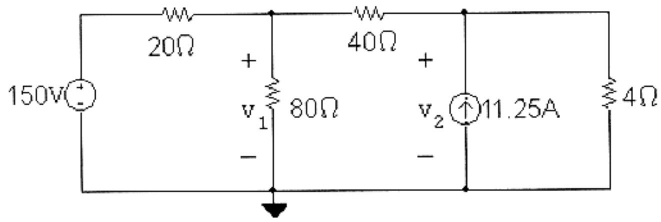
$$v_1\left(-\frac{1}{8}\right) + v_2\left(\frac{1}{8}+\frac{1}{80}+\frac{1}{120}\right) = -1$$

Solving, $v_1 = 120$ V and $v_2 = 96$ V.

Check this result by calculating the power associated with each component:

Component	Power Delivered (W)	Power Absorbed (W)
6A	$-(6\text{ A})(120\text{ V}) = -720$	
40 Ω		$\frac{120^2}{40} = 360$
8 Ω		$\frac{(120-96)^2}{8} = 72$
80 Ω		$\frac{96^2}{80} = 115.2$
120 Ω		$\frac{96^2}{120} = 76.8$
1 A		$(96\text{ V})(1\text{ A}) = 96$
Total	-720	720

P 4.12



The two node voltage equations are:

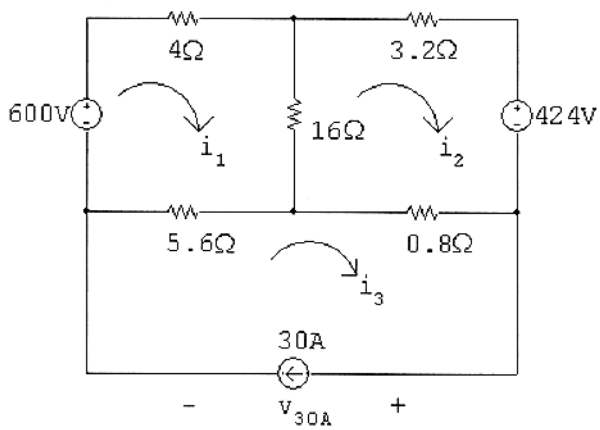
$$\begin{aligned}\frac{v_1 - 150}{20} + \frac{v_1}{80} + \frac{v_1 - v_2}{40} &= 0 \\ \frac{v_2 - v_1}{40} - 11.25 + \frac{v_2}{4} &= 0\end{aligned}$$

Place these equations in standard form:

$$\begin{aligned}v_1\left(\frac{1}{20} + \frac{1}{80} + \frac{1}{40}\right) \quad + \quad v_2(-\frac{1}{40}) &= \frac{150}{20} \\ v_1\left(-\frac{1}{40}\right) \quad + \quad v_2\left(\frac{1}{40} + \frac{1}{4}\right) &= 11.25\end{aligned}$$

Solving, $v_1 = 100$ V; $\quad v_2 = 50$ V

P 4.37



$600 = 25.6i_1 - 16i_2 - 5.6i_3$

$-424 = -16i_1 + 20i_2 - 0.8i_3$

$30 = i_3$

Solving, $i_1 = 35$ A; $\quad i_2 = 8$ A; $\quad i_3 = 30$ A

[a] $v_{30A} = 0.8(i_2 - i_3) + 5.6(i_1 - i_3)$

$= 0.8(8 - 30) + 5.6(35 - 30) = 10.4$ V

$p_{30A} = 30v_{30A} = 30(10.4) = 312$ W (abs)

Therefore, the 30 A source delivers -312 W.

[b] $p_{600V} = -600(35) = -21{,}000$ W(del)

$p_{424V} = 424(8) = 3392$ W(abs)

Therefore, the total power delivered is $21{,}000$ W

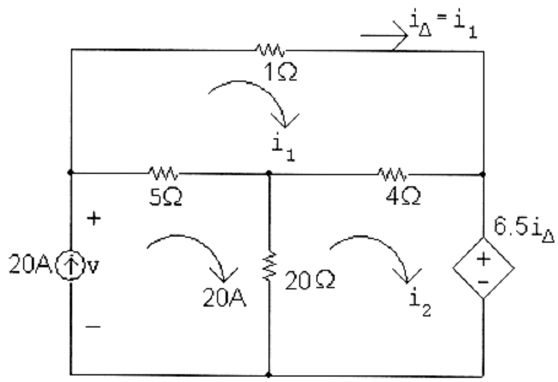
[c]

$$\begin{aligned} p_{4\Omega} &= (35)^2(4) = 4900 \text{ W} \\ p_{3.2\Omega} &= (8)^2(3.2) = 204.8 \text{ W} \\ p_{16\Omega} &= (35 - 8)^2(16) = 11{,}664 \text{ W} \\ p_{5.6\Omega} &= (35 - 30)^2(5.6) = 140 \text{ W} \\ p_{0.8\Omega} &= (-30 + 8)^2(0.8) = 387.2 \text{ W} \end{aligned}$$

$\sum p_{\text{resistors}} = 17{,}296$ W

$\sum p_{\text{abs}} = 17{,}296 + 312 + 3392 = 21{,}000$ W (CHECKS)

P 4.40



Since the bottom left mesh current value is known, we need only two mesh current equations:

$$1i_1 + 4(i_1 - i_2) + 5(i_1 - 20) = 0$$

$$6.5i_1 + 20(i_2 - 20) + 4(i_2 - i_1) = 0$$

Place these equations in standard form:

$$i_1(1 + 4 + 5) + i_2(-4) = 100$$

$$i_1(6.5 - 4) + i_2(20 + 4) = 400$$

Solving, $i_1 = 16$ A; $i_2 = 15$ A

Find v:

$-v + 5(20 - i_1) + 20(20 - i_2) = 0 \quad \therefore \quad v = 5(4) + 20(5) = 120$ V

Calculate the power:

$$p_{20\text{A}} = -(120)(20) = -2400 \text{ W}$$

$$p_{\text{dep source}} = [6.5(16)](15) = 1560 \text{ W}$$

$$p_{1\Omega} = 1(16)^2 = 256 \text{ W}$$

$$p_{5\Omega} = 5(20 - 16)^2 = 80 \text{ W}$$

$$p_{4\Omega} = 4(16 - 15)^2 = 4 \text{ W}$$

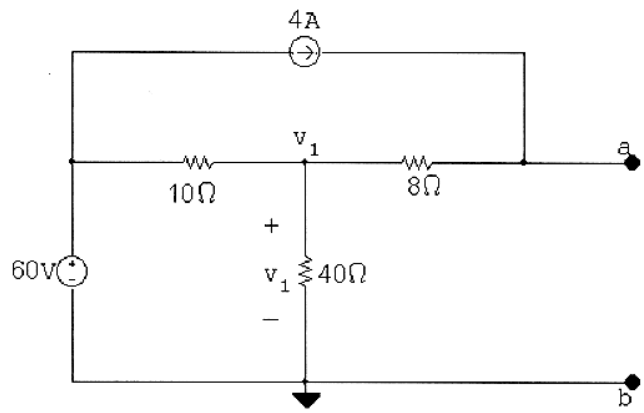
$$p_{20\Omega} = 20(20 - 15)^2 = 500 \text{ W}$$

$$\sum p_{\text{dev}} = 2400 \text{ W}$$

$$\sum p_{\text{dis}} = 1560 + 256 + 80 + 4 + 500 = 2400 \text{ W (checks)}$$

The power developed by the 20 A source is 2400 W

P 4.60



Write and solve the node voltage equation at v_1:

$$\frac{v_1 - 60}{10} + \frac{v_1}{40} - 4 = 0$$

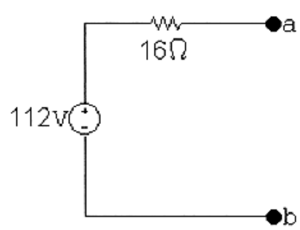
$4v_1 - 240 + v_1 - 160 = 0 \quad \therefore \quad v_1 = 400/5 = 80 \text{ V}$

Calculate V_{Th}:

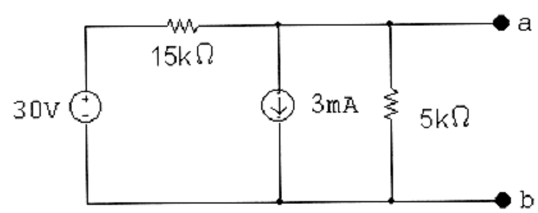
$V_{\text{Th}} = v_1 + (8)(4) = 80 + 32 = 112 \text{ V}$

Calculate R_{Th} by removing the independent sources and making series and parallel combinations of the resistors:

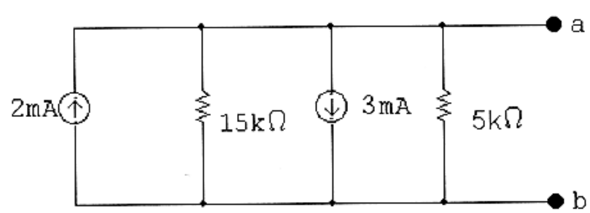
$R_{\text{Th}} = 8 + 40\|10 = 8 + 8 = 16\,\Omega$



P 4.62 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 determined by adding the current sources and combining the resistors in parallel: