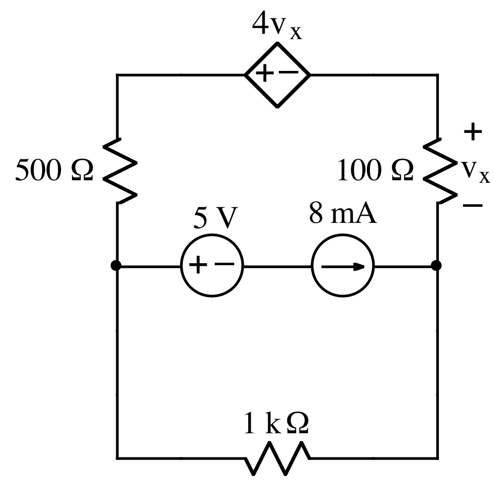
HOMEWORK #8 solution

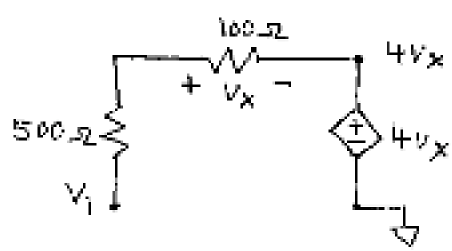
Ex:



Calculate the power dissipated by the dependent voltage source, (labeled $4v_X$).

sol'n: Any method of solution is acceptable. Here, we'll use the node-voltage method.

First, we find v_x in terms of node voltages. If we slide the 100 Ω resistor thru the dependent source, we get the following view of the top branch:



We can find v_x by using a v-divider:

$$-v_x = (4v_x - v_1)\frac{100\,\Omega}{100\,\Omega + 500\,\Omega}$$

or $\frac{2}{3}v_x + v_x = \frac{v_1}{6}$

or $\quad \frac{5}{3} v_X = \frac{v_1}{6}$

or $\quad v_X = \frac{v_1}{6} \cdot \frac{3}{5} = \frac{v_1}{10}$

For the node-voltage eq'n, we have the following:

$$\frac{\left(v_1 - 4\frac{v_1}{10}\right)}{100\,\Omega + 500\,\Omega} + 8\,mA + \frac{v_1 - 0V}{1k\Omega} = 0A$$

Note: The 5V src has no effect as it is in series with a current source.

Now we solve for v_1.

$$v_1\left(\frac{1-\frac{4}{10}}{600\,\Omega} + \frac{1}{1k\Omega}\right) = -8mA$$

or $\quad v_1\left(\frac{0.6}{600\,\Omega} + \frac{1}{1k\Omega}\right) = -8\,mA$

or $\quad v_1 = \frac{-8\,mA}{\frac{2}{1k\Omega}} = -\frac{8\,mA \cdot 1k\Omega}{2} = -4V$

Thus, $\quad 4v_X = 4 \cdot \frac{v_1}{10} = -1.6\,V.$

To find the current thru the $4v_X$ src, we use a term from the node-v eq'n:

$$i = \frac{V_1 - 4V_x}{100\Omega + 500\Omega} = \frac{-4V - (-1.6V)}{600\Omega}$$

$$\text{or } i = \frac{-4 + 1.6}{600\Omega} V = \frac{-2.4V}{600\Omega} = -4 \text{ mA}$$

The power dissipated is $p = i \cdot 4V_x$

$$p = -4 \text{ mA} \cdot (-1.6V)$$

$$p = +6.4 \text{ mW}$$

Note: In this problem, the dependent source is equivalent to a resistor. That is, we can write both the voltage and current for the source as V_x multiplied by a constant. In particular, the current for the $4V_x$ source is the same as the current in the 100Ω resistor and is $i = \frac{V_x}{100\Omega}$.

Using Ohm's law, we have the following expression for the resistor that is equivalent to the source:

$$R_{eq} = \frac{4V_x}{i} = \frac{4V_x}{\frac{V_x}{100\Omega}} = 400\Omega$$

We may use 400Ω in place of the dependent src and solve the problem as an i-divider.