Subject: ECE221 Fall'12 PS2 Solution
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Date: 09/12/2012 09:07 PM
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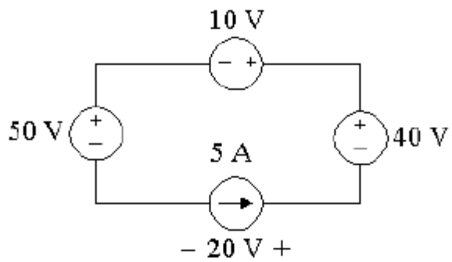
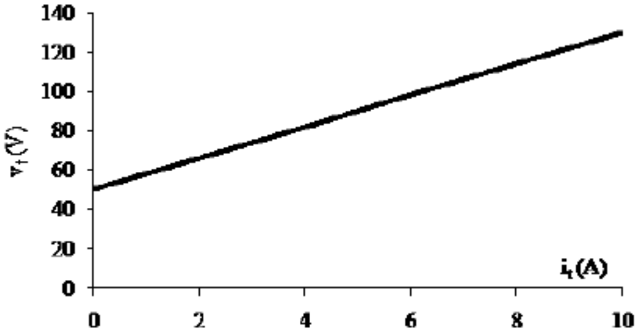
P 2.1 The interconnect is valid since the voltage sources can all carry 5 A of current supplied by the current source, and the current source can carry the voltage drop required by the interconnection. Note that the branch containing the 10 V, 40 V, and 5 A sources must have the same voltage drop as the branch containing the 50 V source, so the 5 A current source must have a voltage drop of 20 V, positive at the right. The voltages and currents are summarize in the circuit below:



$$P_{50V} = (50)(5) = 250 \text{ W} \quad \text{(abs)}$$
$$P_{10V} = (10)(5) = 50 \text{ W} \quad \text{(abs)}$$
$$P_{40V} = -(40)(5) = -200 \text{ W} \quad \text{(dev)}$$
$$P_{5A} = -(20)(5) = -100 \text{ W} \quad \text{(dev)}$$
$$\sum P_{\text{dev}} = 300 \text{ W}$$

P 2.7 The interconnection is invalid. In the middle branch, the value of the current i_Δ must be -25 A, since the 25 A current source supplies current in this branch in the direction opposite the direction of the current i_Δ. Therefore, the voltage supplied by the dependent voltage source in the left hand branch is $6(-25) = -150$ V. This gives a voltage drop from the top terminal to the bottom terminal in the left hand branch of $50 - (-150) = 200$ V. But the voltage drop between these same terminals in the right hand branch is 250 V, due to the voltage source in that branch. Therefore, the interconnection is invalid.

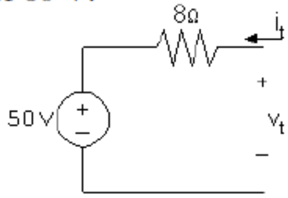
P 2.15 [a] Plot the $v - i$ characteristic



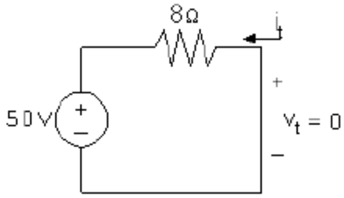
From the plot:

$$R = \frac{\Delta v}{\Delta i} = \frac{(130 - 50)}{(10 - 0)} = 8\,\Omega$$

When $i_t = 0$, $v_t = 50$ V; therefore the ideal voltage source has a voltage of 50 V.



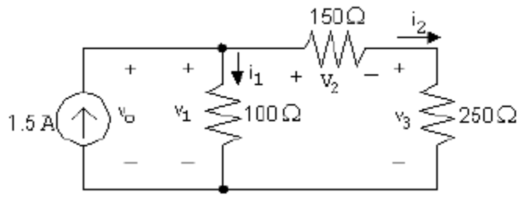
[b]



When $v_t = 0$, $\quad i_t = \frac{-50}{8} = -6.25\text{A}$

Note that this result can also be obtained by extrapolating the $v - i$ characteristic to $v_t = 0$.

P 2.18



[a] Write a KCL equation at the top node:

$-1.5 + i_1 + i_2 = 0 \qquad$ so $\qquad i_1 + i_2 = 1.5$

Write a KVL equation around the right loop:

$-v_1 + v_2 + v_3 = 0$

From Ohm's law,

$v_1 = 100i_1, \qquad v_2 = 150i_2, \qquad v_3 = 250i_2$

Substituting,

$-100i_1 + 150i_2 + 250i_2 = 0 \qquad$ so $\qquad -100i_1 + 400i_2 = 0$

Solving the two equations for i_1 and i_2 simultaneously,

$i_1 = 1.2\,\text{A} \qquad$ and $\qquad i_2 = 0.3\,\text{A}$

[b] Write a KVL equation clockwise around the left loop:

$-v_o + v_1 = 0 \qquad$ but $\qquad v_1 = 100i_1 = 100(1.2) = 120\,\text{V}$

So $\qquad v_o = v_1 = 120\,\text{V}$

[c] Calculate power using $p = vi$ for the source and $p = Ri^2$ for the resistors:

$p_{\text{source}} = -v_o(1.5) = -(120)(1.5) = -180\,\text{W}$

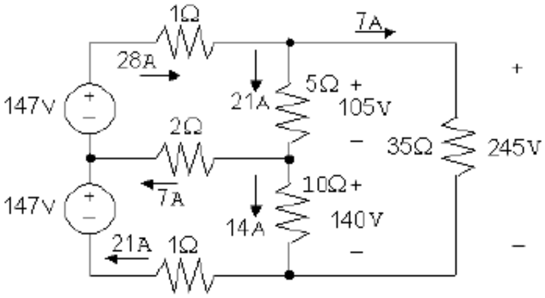
$p_{100\Omega} = 1.2^2(100) = 144\,\text{W}$

$p_{150\Omega} = 0.3^2(150) = 13.5\,\text{W}$

$p_{250\Omega} = 0.3^2(250) = 22.5\,\text{W}$

$\sum P_{\text{dev}} = 180\,\text{W} \qquad \sum P_{\text{abs}} = 144 + 13.5 + 22.5 = 180\,\text{W}$

P 2.25 [a] Start by calculating the voltage drops due to the currents i_1 and i_2. Then use KVL to calculate the voltage drop across and 35 Ω resistor, and Ohm's law to find the current in the 35 Ω resistor. Finally, KCL at each of the middle three nodes yields the currents in the two sources and the current in the middle 2 Ω resistor. These calculations are summarized in the figure below:



$$p_{147(\text{top})} = -(147)(28) = -4116 \text{ W}$$
$$p_{147(\text{bottom})} = -(147)(21) = -3087 \text{ W}$$

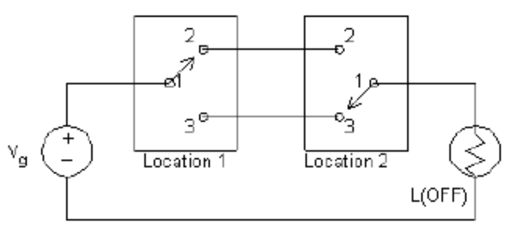
Therefore the top source supplies 4116 W of power and the bottom source supplies 3087 W of power.

[b]

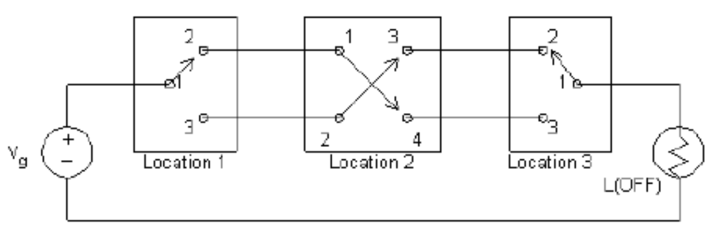
$$\sum P_{\text{dis}} = (28)^2(1) + (7)^2(2) + (21)^2(1) + (21)^2(5) + (14)^2(10) + (7)^2(35)$$
$$= 784 + 98 + 441 + 2205 + 1960 + 1715 = 7203 \text{ W}$$
$$\sum P_{\text{sup}} = 4116 + 3087 = 7203 \text{ W}$$

Therefore, $\sum P_{\text{dis}} = \sum P_{\text{sup}} = 7203$ W

P 2.33 [a]



[b]



shock.

P 2.38 $R_{\text{space}} = 1\ \text{M}\Omega$

$$i_{\text{space}} = 3\ \text{mA}$$

$$v = i_{\text{space}} R_{\text{space}} = 3000\,\text{V}.$$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