School of Electrical Engineering and Computer Science, University of Ottawa

Circuit Theory I

ELG2138B **Fall 2018**

Problem Set #1 (total 4 problems: 5 pts each)

<u>Due: 9/17/2018, 8:30am</u>

No late homework is accepted.

P 1. Conservation of energy requires that the sum of the power absorbed by all of the elements in a circuit be zero. Figure P 1 shows a circuit. All of the element voltages and currents are specified. Are these voltage and currents correct? Justify your answer.

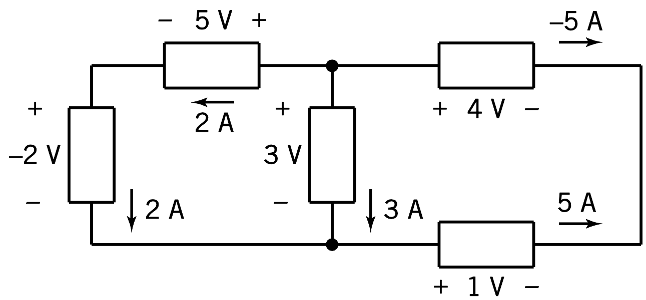


Figure P 1

Hint: Calculate the power absorbed by each element. Add up all of these powers. If the sum is zero, conservation of energy is satisfied and the voltages and currents are probably correct. If the sum is not zero, the element voltages and currents cannot be correct.

Solution:

Notice that the element voltage and current of each branch adhere to the passive convention. The sum of the powers absorbed by each branch are:

$$(-2\text{ V})(2\text{ A})+(5\text{ V})(2\text{ A})+(3\text{ V})(3\text{ A})+(4\text{ V})(-5\text{ A})+(1\text{ V})(5\text{ A}) = -4\text{ W} + 10\text{ W} + 9\text{ W} -20\text{ W} + 5\text{ W} = 0\text{ W}$$

The element voltages and currents satisfy conservation of energy and may be correct.

P 2 Determine the values of the resistances R_1 and R_2 for the circuit shown in Figure P 2.

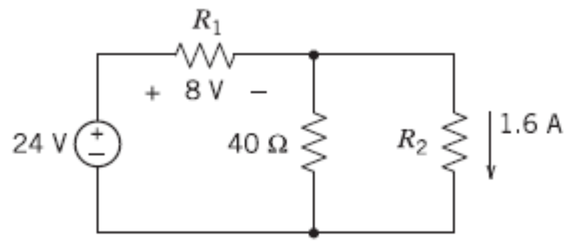


Figure P 2

Solution:

Using voltage division

$$8=\frac{R_1}{R_1+\frac{40R_2}{R_2+40}}\times 24 \quad\Rightarrow\quad \frac{1}{3}=\frac{R_1(R_2+40)}{R_1R_2+40(R_1+R_2)}$$

$$\Rightarrow\quad R_1R_2+40(R_1+R_2)=3R_1R_2+120R_1 \quad\Rightarrow\quad R_1=\frac{40R_2}{2R_2+80}$$

Using KVL

$$24=8+R_2(1.6) \quad\Rightarrow\quad R_2=10\ \Omega$$

Then

$$R_1=\frac{40(10)}{2(10)+80}=4\ \Omega$$

P 3. Determine the power supplied by each source in the circuit shown in Figure P 3.

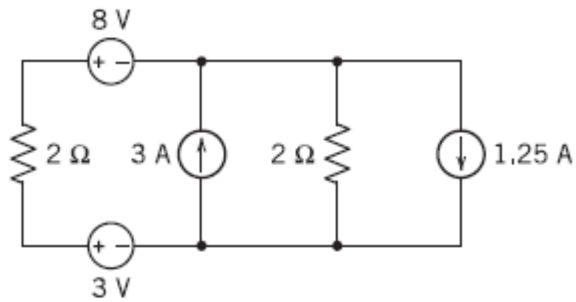
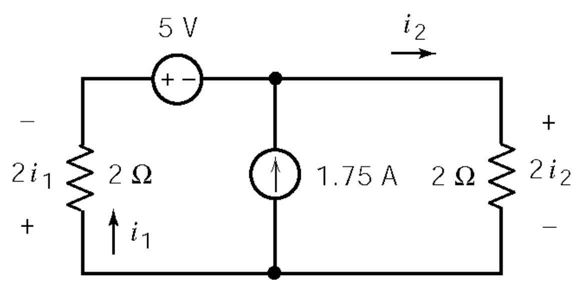


Figure P 3

Solution:

The voltage sources are connected in series and can be replaced by a single equivalent voltage source. Similarly, the parallel current sources can be replaced by an equivalent current source.

After doing so, and labeling the resistor currents, we have the circuit shown.



Apply KCL at the top node of the current source to get

$$i_1 + 1.75 = i_2$$

Apply KVL to the outside loop to get

$$5 + 2i_2 + 2i_1 = 0$$

so

$$5 + 2(i_1 + 1.75) + 2i_1 = 0 \quad \Rightarrow \quad i_1 = -\frac{8.5}{4} = -2.125 \text{ A}$$

and

$$i_2 = -2.125 + 1.75 = -0.375 \text{ A}$$

The power supplied by each sources is:

Source	Power delivered
8-V voltage source	$-8i_1 = 17$ W
3-V voltage source	$3i_1 = -6.375$ W
3-A current source	$3 \times 2i_2 = -2.25$ W
1.25-A current source	$-1.25 \times 2i_2 = 0.9375$ W

P 4 Determine the power supplied by each source in the circuit shown in Figure P 4.

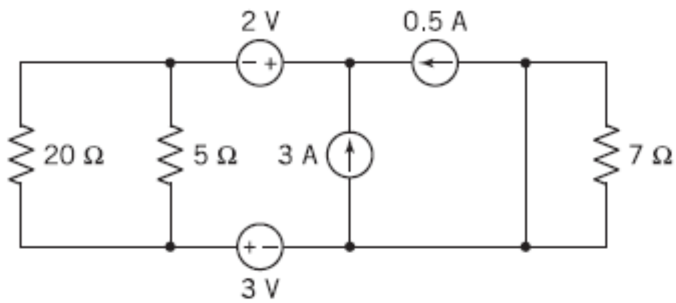


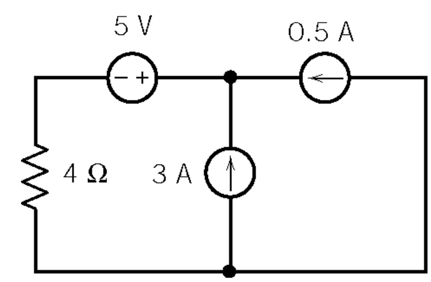
Figure P 4

Solution:

The 20-Ω and 5-Ω resistors are connected in parallel. The equivalent resistance is $\frac{20\times5}{20+5}=4\ \Omega$. The 7-Ω resistor is connected in parallel with a short circuit, a 0-Ω resistor. The equivalent resistance is $\frac{0\times7}{0+7}=0\ \Omega$, a short circuit.

The voltage sources are connected in series and can be replaced by a single equivalent voltage source.

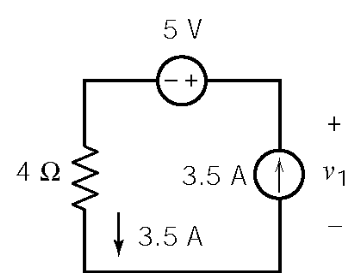
After doing so, and labeling the resistor currents, we have the circuit shown.



The parallel current sources can be replaced by an equivalent current source.

Apply KVL to get

$$-5+v_1-4(3.5)=0 \quad \Rightarrow \quad v_1=19\text{ V}$$



The power supplied by each sources is:

Source	Power delivered
8-V voltage source	$-2(3.5)=-7$ W
3-V voltage source	$-3(3.5)=-10.5$ W
3-A current source	$3\times19=57$ W
0.5-A current source	$0.5\times19=9.5$ W