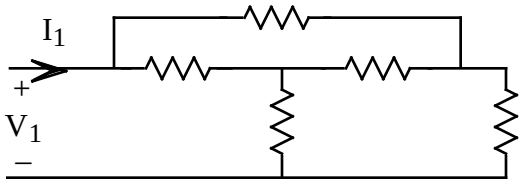
ECE 109 - EQUIVALENT CIRCUITS - INVESTIGATION 20
THEVENIN'S THEOREM - PART III

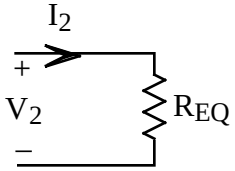
SUMMER 2007 **A.P. FELZER**

To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs and tables.

We know from previous Investigations that purely resistor circuits like the following



satisfy $V_1 = R_{EQ} I_1$ and so are **equivalent** to single resistors as follows



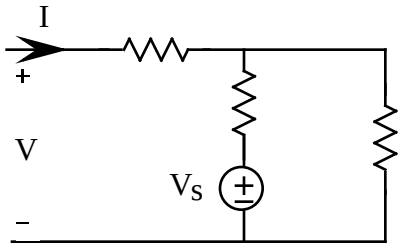
since **whenever** $V_1 = V_2$ **then** $I_1 = I_2$

The objective of this Investigation is to make use of R_{TH} and V_{TH} which we can calculate in two ways

(1) Connect a source across the circuit and then calculate V as a function of I

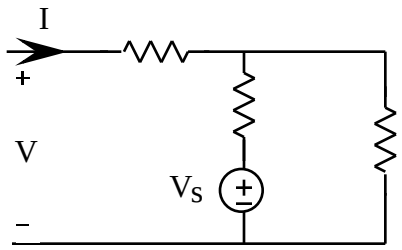
(2) Find V_{TH} by calculating the open circuit voltage and R_{TH} by calculating the equivalent resistance of the circuit with all the sources set to zero

to find simple equivalent circuits for resistor circuits containing sources like the following



Be sure to take a look at the **Computer Demos** on Thevenin's Equivalent.

1. Suppose that V and I in the following circuit



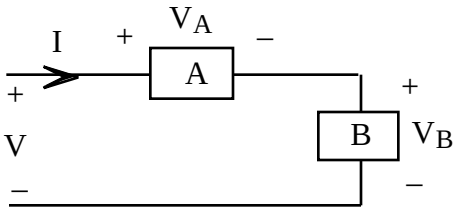
are related by the equation

$$V = 1000I + 5$$

Since V is the sum of two voltages as follows

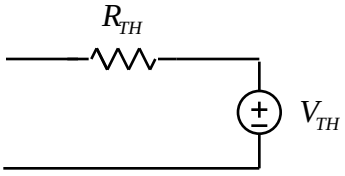
$$V = V_A + V_B$$

where $V_A = 1000I$ and $V_B = 5$, we should be able to come up with an equivalent circuit of the following form

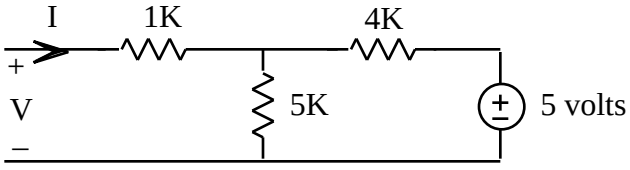


a. Explain why we have put A and B in series
b. Find circuit elements A and B so that the voltage drops across them are $V_A = 1000I$ and $V_B = 5$ volts. Draw the corresponding circuit.
c. Generalize on your results to find and draw an equivalent circuit for a circuit with $V = R_{TH}I + V_{TH}$

2. From Problem (1) we have that if N is a resistor circuit containing sources with $V = R_{TH}I + V_{TH}$ then N is equivalent to the following nice simple circuit

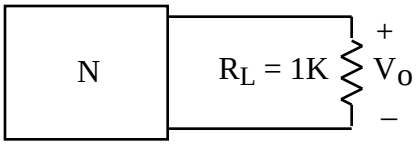


We refer to this circuit as the **Thevenin Equivalent** of N. Given the following circuit



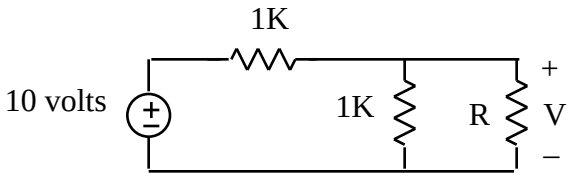
a. Find R_{TH} and V_{TH}
b. Make use of your result in part (a) to find and draw the Thevenin Equivalent circuit

3. Given the following circuit

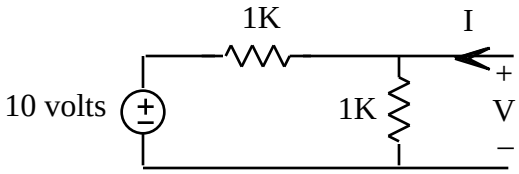


Find V_o if N has the Thevenin Equivalent $R_{TH} = 2K$ and $V_{TH} = 3$ volts. *Be sure to draw the equivalent circuit before you write any equations.* Note that we refer to R_L as the **load resistor** of N.

4. Given the following circuit

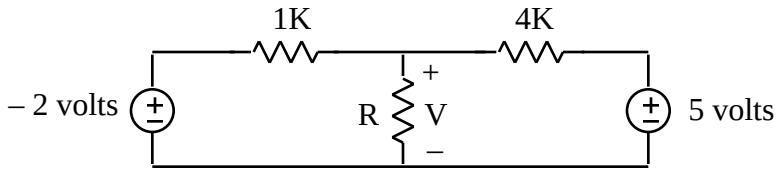


a. Find and draw the Thevenin equivalent as seen by R - the Thevenin Equivalent of

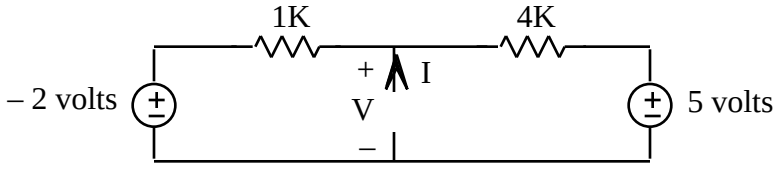


b. Make use of your result in part (a) to find V when $R = 2K$. *Be sure to draw the equivalent circuit before you write any equations.*

5. Given the following circuit

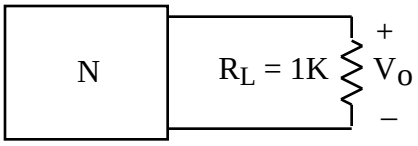


a. Find the Thevenin Equivalent as seen by R - the Thevenin Equivalent of



b. Make use of your result in part (a) to find V when $R = 1K$. *Again be sure to draw the equivalent circuit before writing any equations to find V*

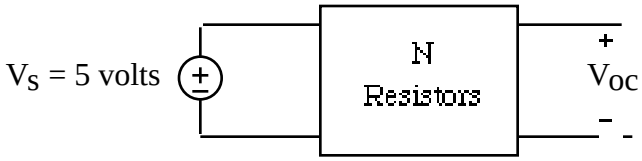
6. Given the following circuit



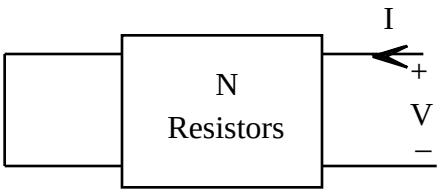
with N having the Thevenin Equivalent $R_{TH} = 2K$ and $V_{TH} = -5$ volts

a. Find the power being delivered to R_L
b. How much energy will be delivered to R_L in 5 minutes

7. The objective of this and the next problem is to make use of gains G in the calculation of Thevenin Equivalents. Find and draw the Thevenin Equivalent of the following circuit

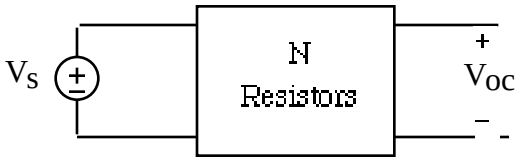


if N has an *open circuit voltage gain* $G = V_{OC} / V_S = 0.5$ and the equivalent resistance of the circuit when V_S is set to zero as follows



is R_{EQ} = 2K

8. Find and draw the general form of the Thevenin Equivalent of the following circuit



if N has an open circuit voltage gain $G = V_{OC} / V_S$ and the equivalent resistance when V_S is set to zero is R_{EQ}

9. Math Review: Sketch three periods of a periodic signal of period $T = 0.1$ seconds