Homework #1
Solution

1. Standard Wheatstone Bridge

The sign of the output voltage of a bridge circuit depends on how the output is connected to whatever is reading it. The magnitude of the voltage is given by the difference between the voltages on the two voltage dividers that make up the bridge.

$$V_{Th} = E*R3/(R1+R3) - E*Rx/(R2+Rx)$$

For the Thevenin resistance, we have short out the voltage source and obtain the same circuit as Gingrich did in his example, except that we now have symbols for resistance rather than numbers. The resistance is then the parallel combination of R1 and R3 in series with the parallel combination of R2 and Rx or

$$R_{Th} = R1*R3/(R1+R3) + R2*Rx/(R2+Rx)$$

2. Voltage Divider from Page 5 of Mini-Notebook

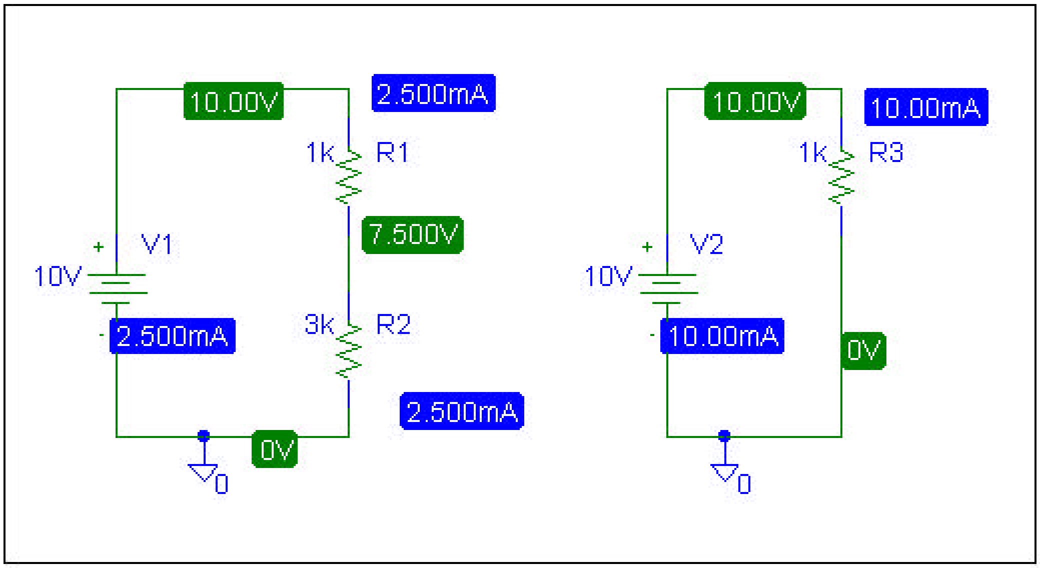
The output voltage of the divider is given as

$$V_{OUT} = V_{IN}*R2/(R1+R2)$$

This is also the Thevenin voltage. To determine the Thevenin resistance, we short out the voltage source, which results in a parallel combination of R1 and R2. The Thevenin resistance is

$$R_{Th} = (R1*R2)/(R1+R2)$$

Just for fun, I simulated this divider under open circuit and short circuit conditions, since V_{Th} is the open circuit voltage and R_{Th} is the ration of the open circuit voltage to the short circuit current.



Plugging into the formulas on the previous page, we see that V_{Th} = 7.5 volts, which agrees with the voltage at the point between R1 and R2 in the left diagram. The formula for R_{Th} gives 750 ohms. Using the PSpice results we obtain the same thing by taking the ratio of the open circuit voltage (7.5 volts) to the short circuit current (10mA from the right diagram). We can do the same kind of analysis with the bridge circuit.