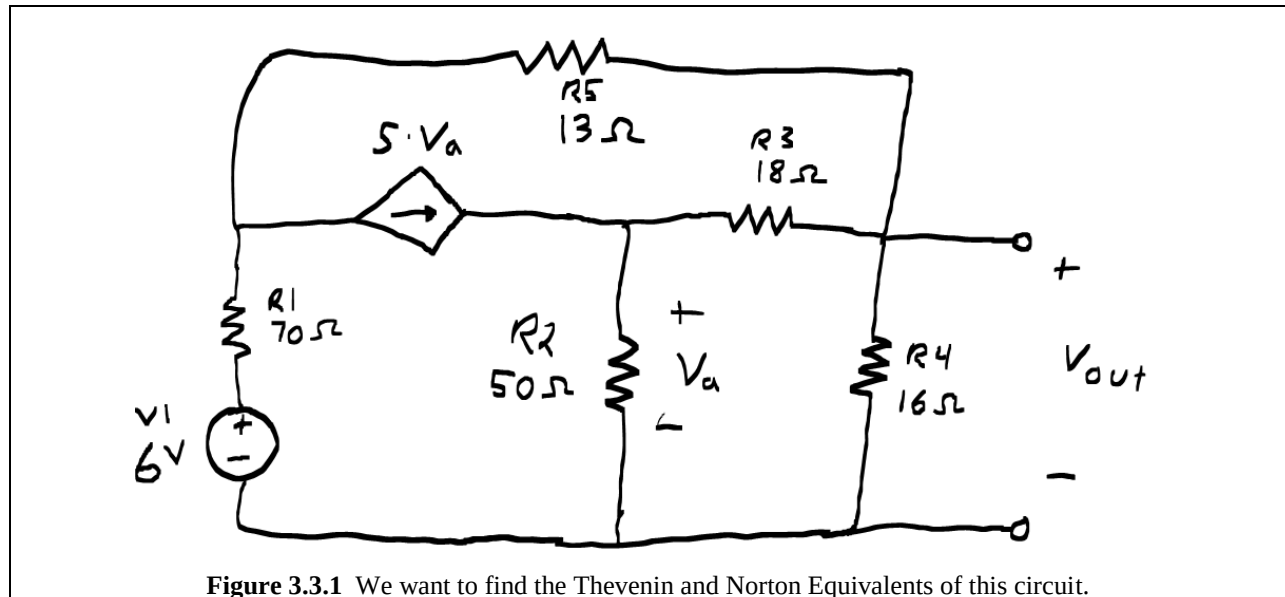


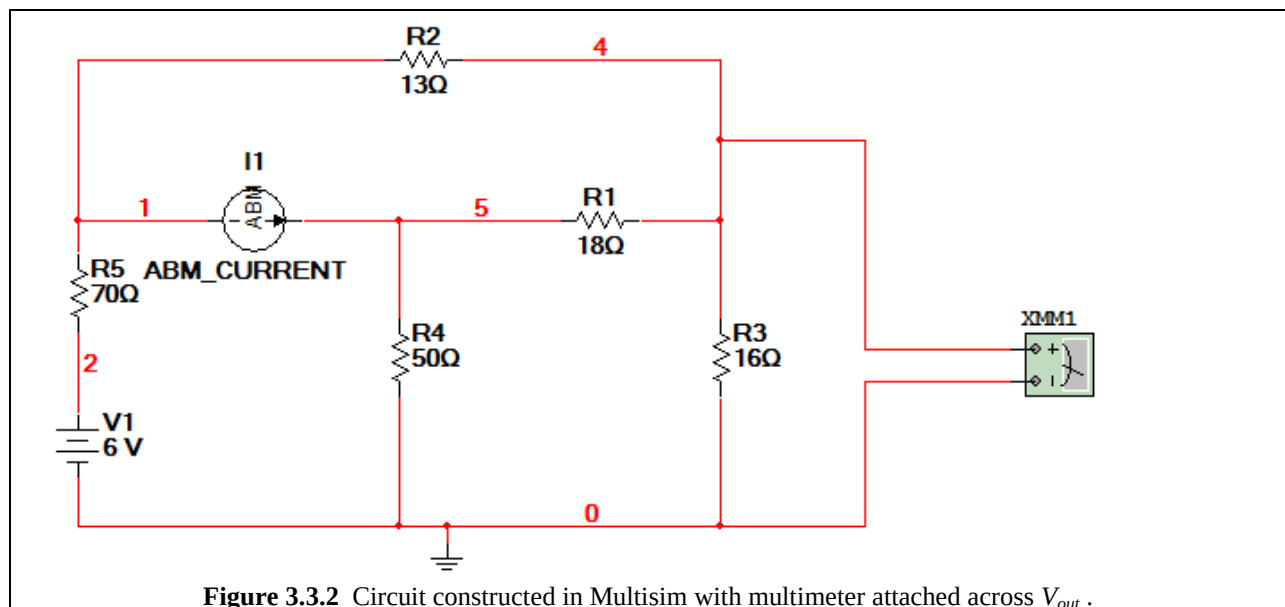
EXERCISE 3.3 MULTISIM AND THEVENIN AND NORTON CIRCUITS

Multisim can be used to easily determine Thevenin and Norton Equivalents of circuits. While you should of course know how to do this by hand, the plethora of Multisim tools at your disposal makes generating Thevenin and Norton circuit an easy task.

Let's find the Thevenin and Norton Equivalent circuits for the somewhat complicated circuit shown in Fig. 3.3.1 below.



Use an ABM_CURRENT source for the dependent source, and place a Multimeter instrument across the terminals of the circuit output as shown in Fig. 3.3.2. The Current Value for the dependent source should be: $5 \cdot V(5)$ using the node numbering in Fig. 3.3.2.



We need to find two of three values: Open-circuit voltage V_{OC} , Short-circuit current I_{SC} , and/or Thevenin Resistance R_{TH} . The first two are the easiest to find since we don't need to conduct a major overhaul on the circuit. So double-click on the Multimeter to bring up its screen.

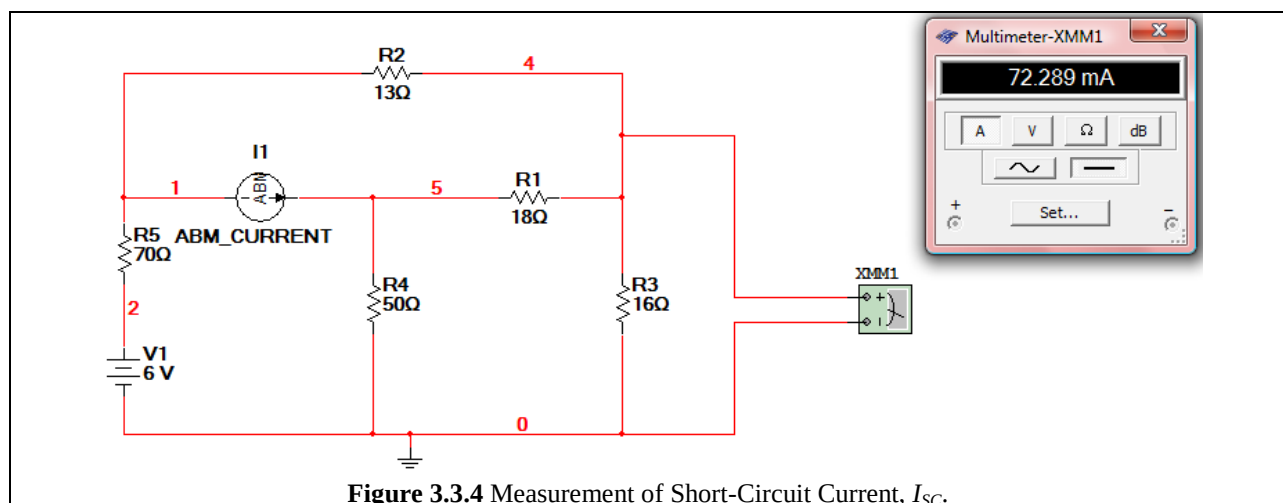
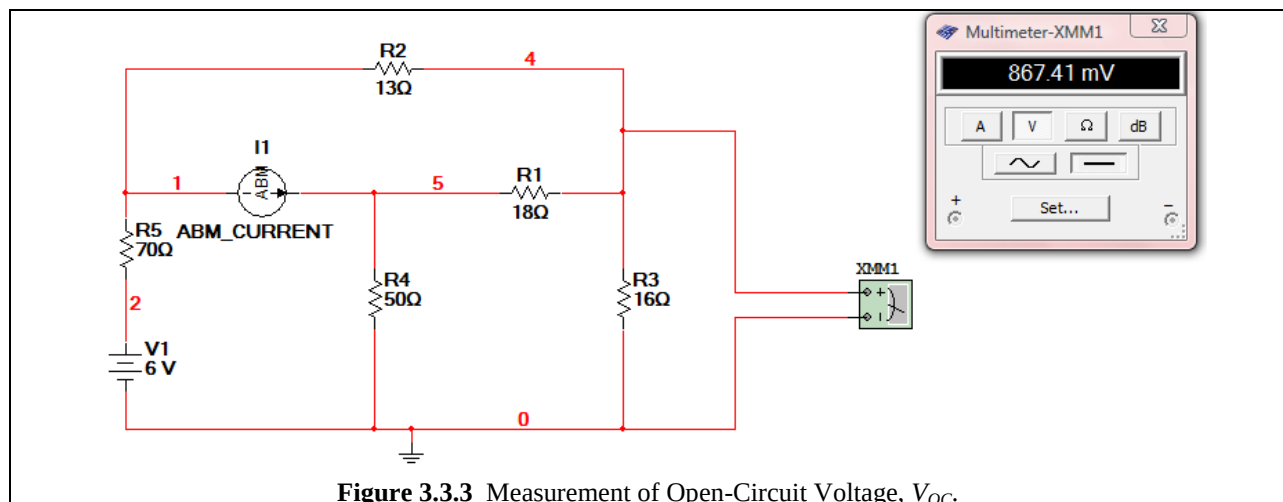
To measure the Open-Circuit Voltage (V_{OC}):

1. Begin the simulation by pressing the  button or F5
2. Activate the Voltage measurement on the Multimeter using the  button
3. Read the output as depicted in Figure 3.3.3

Allow the simulation to continue running. To find the Short-Circuit Current (I_{SC}):

1. Switch the Multimeter to “Ammeter mode” by pressing the  button.
2. Read the output as depicted in Figure 3.3.4.

The resistance between the probe tips of an ideal voltmeter is infinite or open, while the resistance between the probe tips of an ideal ammeter is 0 or shorted. Hence we really are measuring the open-circuit voltage and the short-circuit current through this method.



We now have easily determined the Open-Circuit Voltage and the Short-Circuit Current. These values will allow us to find the Thevenin Resistance because:

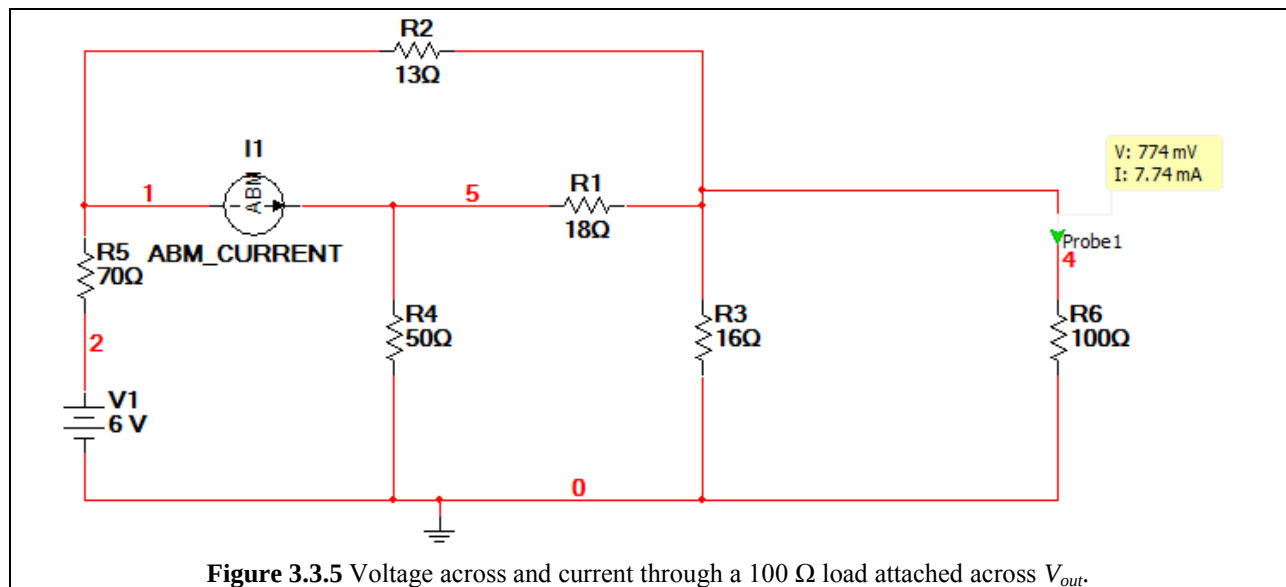
$$R_{Th} = \frac{V_{OC}}{I_{SC}}$$

Using the values which were extracted from the simulations, the Thevenin voltage is:

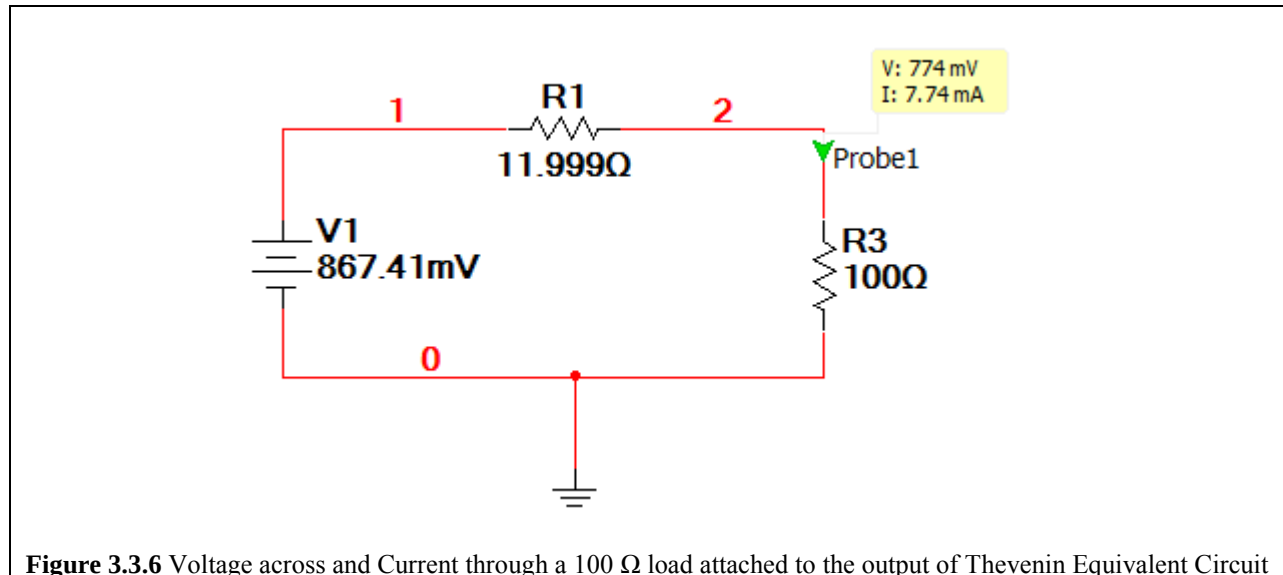
$$R_{Th} = \frac{867.41 \times 10^{-3}}{72.289 \times 10^{-3}} = 11.999 \Omega$$

Since we also know that $V_{OC} = V_{Th}$ and $I_{SC} = I_N$ we can now construct both the Thevenin and Norton Equivalent circuits. Let's do that really quickly and then simultaneously simulate the original circuit, the Norton circuit, and the Thevenin Circuit with a 100Ω load and measure the voltage across and the current through the load resistor.

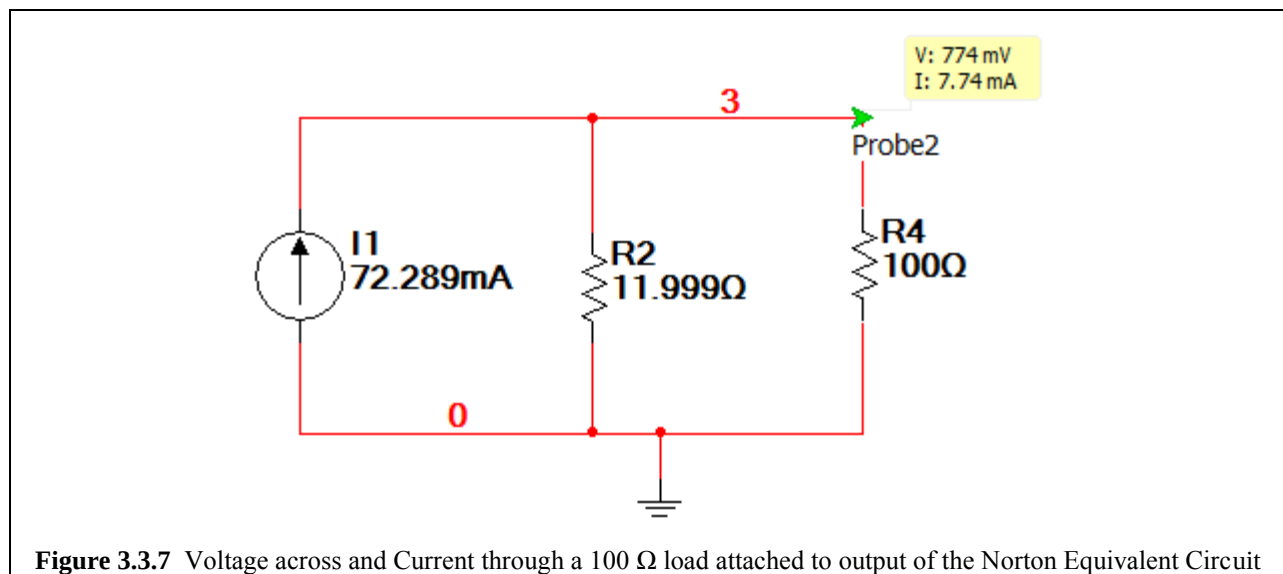
Doing this for the original circuit results in Fig. 3.3.5 below.



Construct the Thevenin circuit in Multisim with the $100\ \Omega$ load. Simulate it and the result should be similar to that shown in Fig 3.3.6 below.



Construct the Norton circuit in Multisim with the $100\ \Omega$ load. Simulate it and the result should be similar to that shown in Fig 3.3.7 below.



As we can see in Figures 3.3.6, 3.3.6, and 3.3.7, the voltage and current across the $100\ \Omega$ is the same, thus confirming that these are the proper Thevenin and Norton Equivalent circuits.

Note that the Thevenin Resistance could have been easily approximated as $12\ \Omega$ and the results would have been fine, but the value was carried out to three decimal places just to ensure that the exact same value showed up in each of the screenshots.