MULTISIM DEMO 3.1: DC CIRCUIT ANALYSIS I

This Demo is going to introduce analysis techniques which will give you a quick and efficient way of working with circuits in the DC domain.

Let's start by building the circuit shown in Fig. 3.1.1.

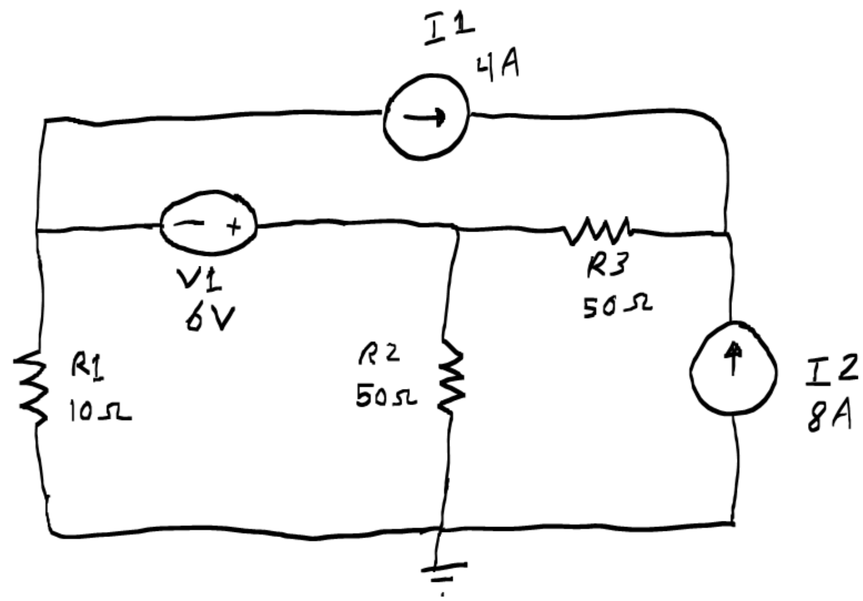

Figure 3.1.1 Schematic of Circuit to be analyzed.

The DC Current sources which we need for this circuit can be found under (see Fig. 3.1.2):

Group: Sources
Family: SIGNAL_CURRENT_SOURCES
Component: DC_CURRENT

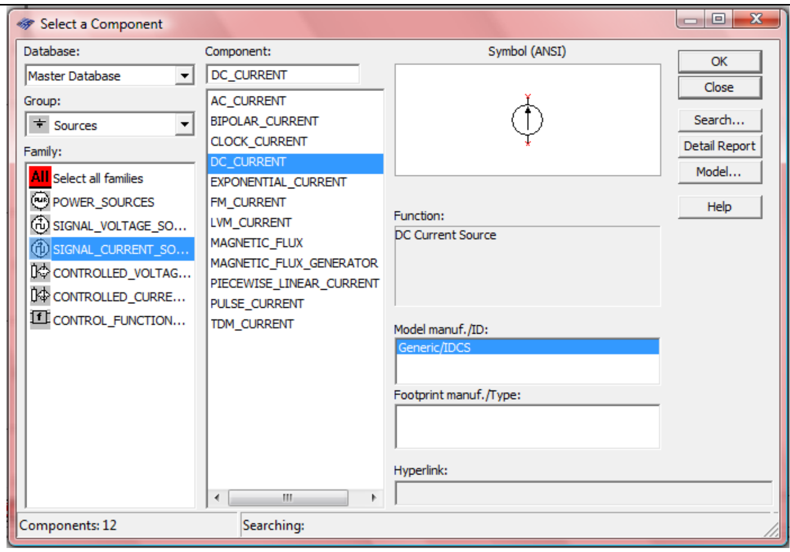

Figure 3.1.2 Select a Component Window showing the appropriate hierarchy for the DC_CURRENT component.

Once all of the components are in place, the schematic should look similar to that shown in Fig. 3.1.3 below.

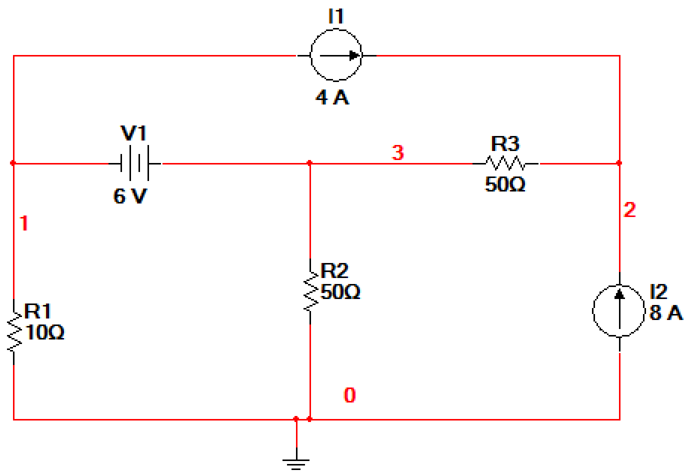

Figure 3.1.3 Schematic implemented in Multisim

Now we need to use the Measurement Probes to analyze the circuit. There are several ways in which to do this. First you can go to Simulate>Instruments>Measurement Probe.

Additionally on the instrument toolbar the Measurement Probe button, , will allow you to reach the same end.

Now, the above two approaches will provide a Measurement probe which has all the possible measurements active by default. Sometimes you might want to just measure a few things, and this can be done by altering the Measurement Probe (we'll get to it in a second). To save time there are also preset Measurement probes, which allow for quicker implementation of measurement probes with only a few fields activated. For example, going to Simulate>Instruments>Preset Measurement Probes will allow you to select from a few.

Similarly clicking on the downward facing arrow of the Measurement Probe button, , will bring up the same options of preset probes .

For now let us just place a generic all-measurements-active Measurement Probe. Place the probe at Node 1, which is the node between the 10 Ω resistor, the 6 VDC source, and the 4 A source. When it is placed, a large, beige colored window with a bunch of empty measurement fields will appear. Additionally, this window may by default be placed in a location which obscures some portion of the circuit. You can move the window just like you can move the Node Voltage label. Once completed, the circuit should resemble something like that shown in Figure 3.1.4 shown on the next page.

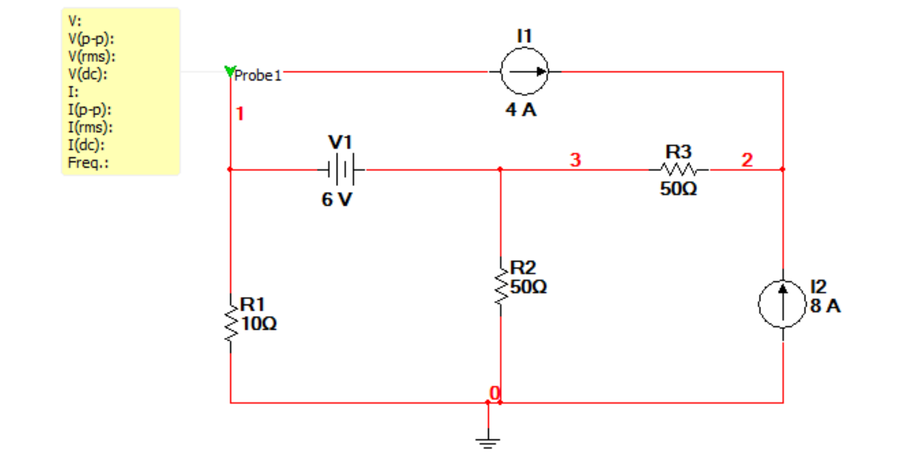

Figure 3.1.4 Circuit with Probe placed.

Place two other probes in the circuit: one at Node 2 and one at Node 3 as shown below in Fig. 3.1.5.

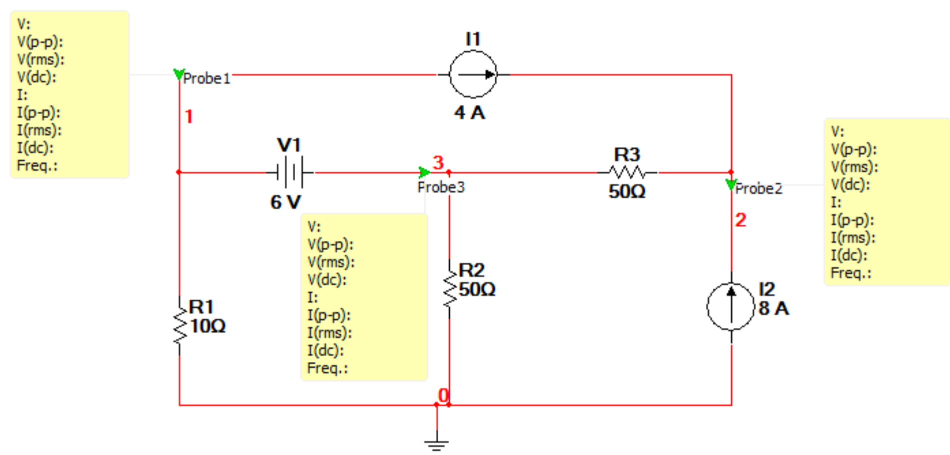

Figure 3.1.5 All three probes are placed.

Be sure to place your probe tips (the green arrows) at the same nodes which are shown in Figure 3.1.5.

Now like mentioned earlier, each probe is measuring a bunch of things which we don't want to measure (and in fact we can't measure some things like V(p-p) since they are AC measurements and this is a DC circuit.)

Really all we care about are voltage and current, so to set it up as such:

1. Double-click on the Measurement Probe box.
2. Click on the Parameters Tab.
3. Click on the cells in the "Show" column which correspond to the measurements you wish to deactivate. (Clicking on the cells in this column toggles on/off the corresponding measurements) (See Fig. 3.1.6 on the next page).
4. Click OK.

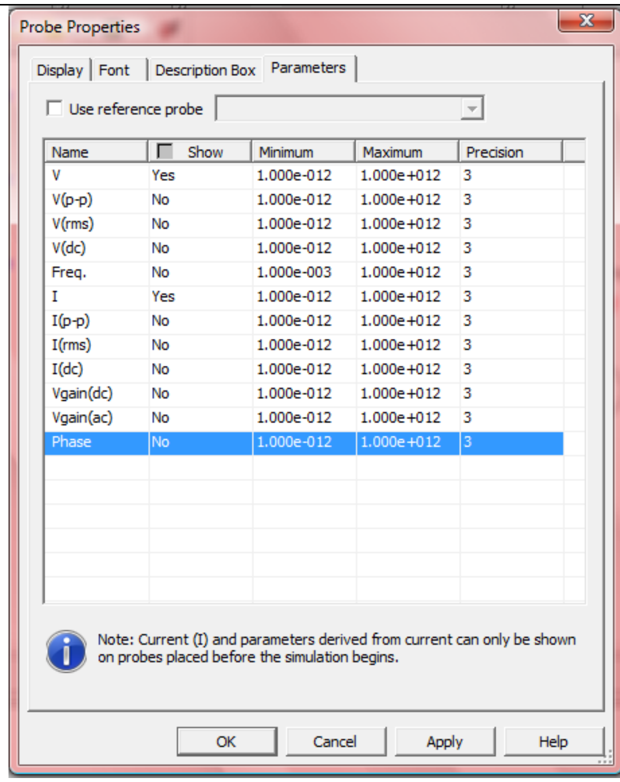

Figure 3.1.6 Probe Properties with only I and V selected.

Do this for all of the probes. As a result, the circuit should look like Fig. 3.1.7.

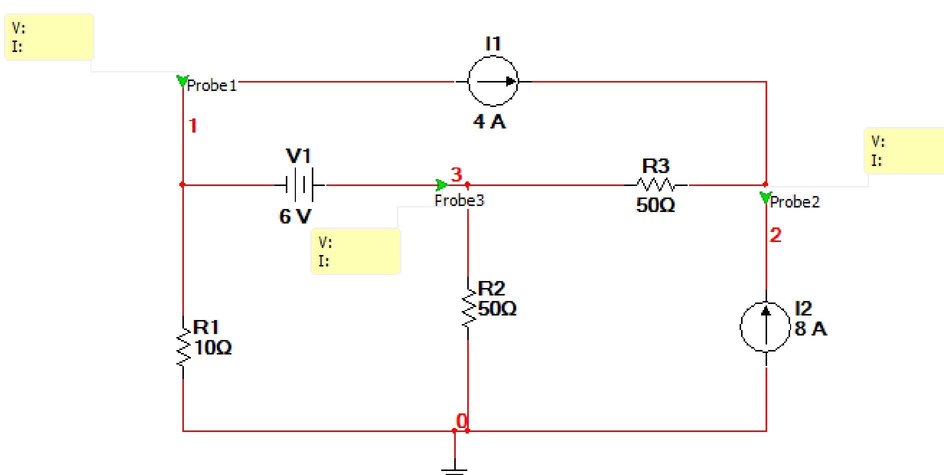

Figure 3.1.7 Circuit with all the probes set to measure only V and I.

To begin the Interactive Simulation, press F5 or the key. When running, the values will be displayed as shown in Fig. 3.1.8 on the next page.

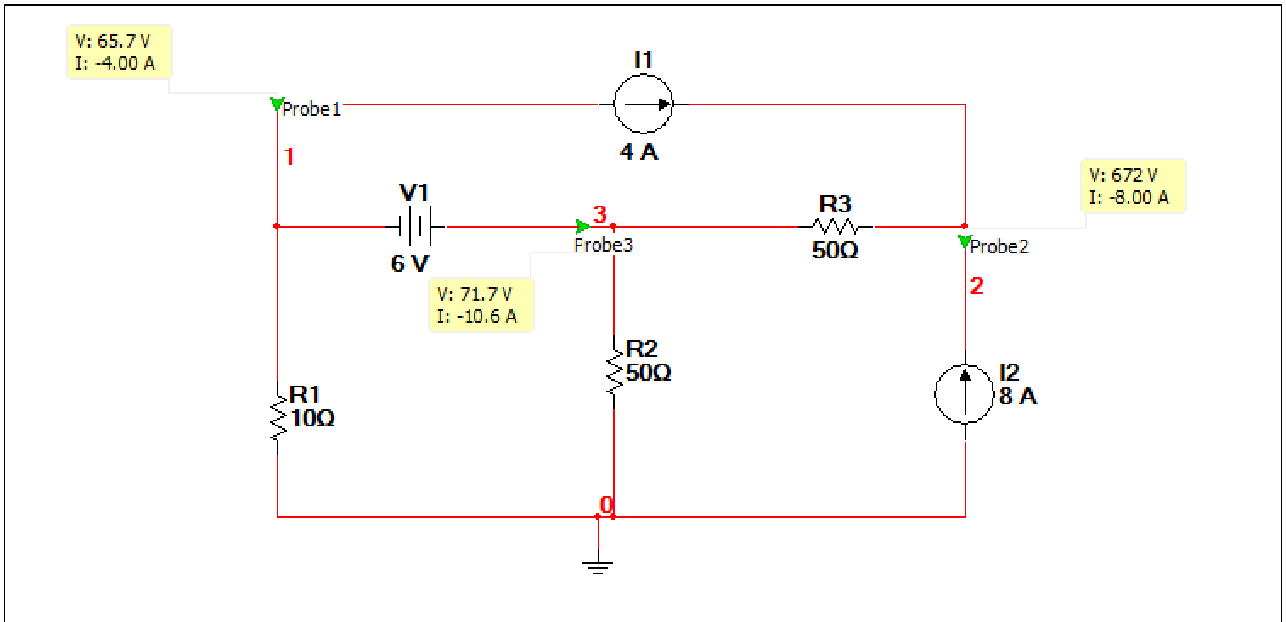

Figure 3.1.8 Probes displaying values in Interactive Simulation mode.

So let's analyze what we have here:

For Probe 1, the voltage is 65.7 V. The current which it is measuring is -4.00 A. Why -4.00 A? This is dictated by the direction of the green arrow which makes up the probe tip. The green arrow is facing in the opposite direction of the arrow on the 4 A current source, and as a result, the probe measures -4.00 A through it.

You can change the direction of the probe tip by right clicking on the green probe arrow, and clicking on Reverse Probe Direction.

For Probe 2, the voltage is 672 V, and the current is -8.00 A, again a value which makes sense because the direction of the arrow is opposite the direction of the 8 A current source.

Finally for Probe 3, the voltage is 71.7 V, and the current is -10.6 A. While a voltage of 71.7 V is correct for Node 3, nodes themselves technically don't have currents in them. In fact, we're really just looking at one of the branches which leads into Node 3. As we all know by now from KCL, the sum of the currents going into a node must equal zero.

Let's verify this notion by adding two more probes to the other two branches of Node 3. Stop the simulation by pressing the button. Place one probe above the 50 Ω resistor R2, and one probe to the left of the 50 Ω resistor R3. Make sure all of the green arrows are pointing in towards the junction of the three wires. Then re-simulate by pressing either F5 or the key.

Zooming in, the result should look like that shown in Figure 3.1.9 on the next page.

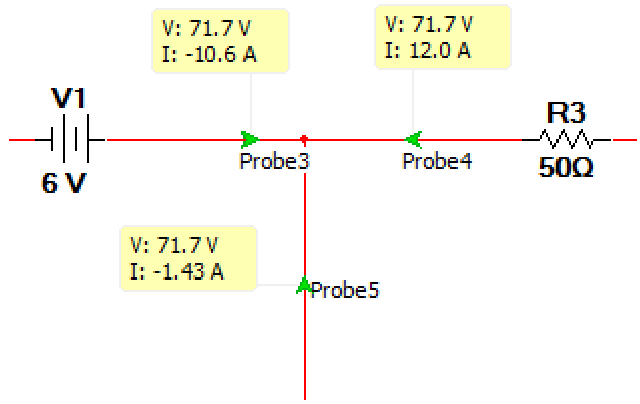

Figure 3.1.9 KCL is upheld!

As expected, the voltages at each branch are 71.7 V (since they all are part of the same node.) If we sum up the currents going into the node we get:

$$-10.6 - 1.43 + 12.0 = 0.03 \text{ A} = 30 \text{ mA}$$

Why doesn't it equal 0 ma? Well, the above value is an artifact of the limited significant figures in the measurements.

We can verify this assumption by going into the Probe Properties of the three probes and increasing the Precision on the I parameter to 5 digits as shown in Fig. 3.1.10 below.

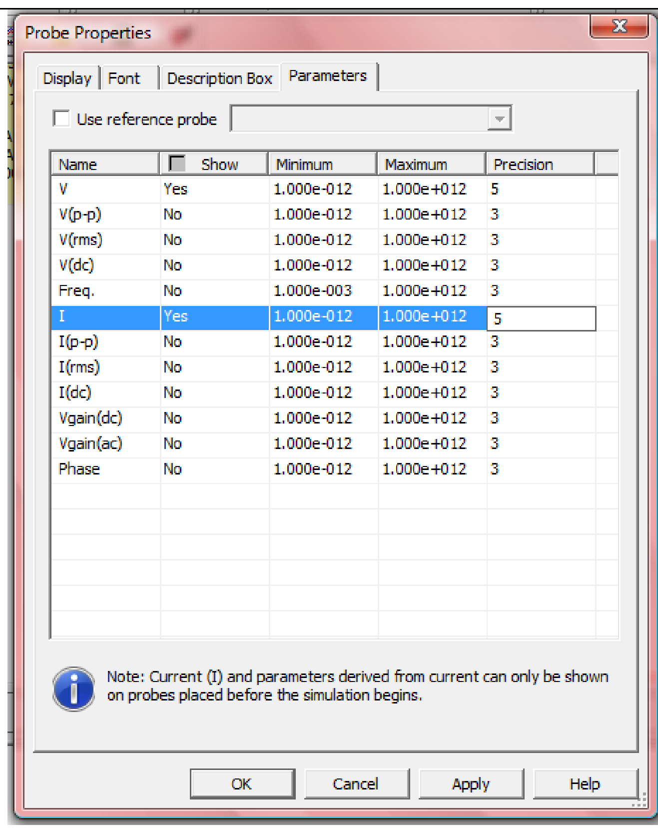

Figure 3.1.10 Increasing the precision for the I value.

Re-run the Interactive Simulation again, in order to get the following currents shown in Fig. 3.1.11.

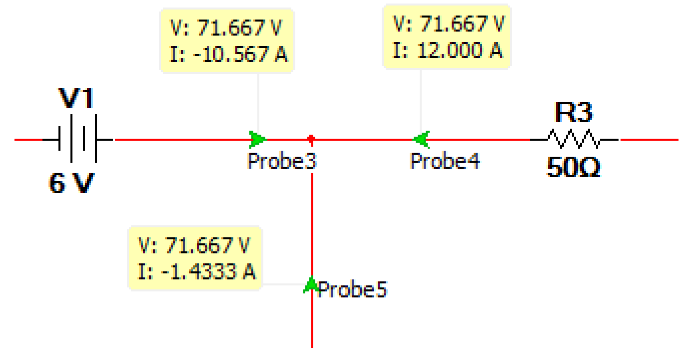

Figure 3.1.11 KCL is conserved again…this time with less error!

Adding up these values we get:

$$-10.567 - 1.4333 + 12.000 = -0.0003 \text{ A} = -300 \ \mu\text{A}.$$

This value is much, much smaller, suggesting that any leftover is just a product of limited decimal places.