Simulator Exercise 04 Name:__________________ Section: _____________

I. Purpose.

1. Review voltage subscript notation
2. Introduce the construction of a DC parallel circuit.
3. Introduce voltage across parallel elements.
4. Introduce the calculation of total resistance of resistive elements connected in parallel.
5. Introduce the application of Kirchhoff's Current Law in the analysis of a DC parallel circuit.

II. Equipment.

Circuit Simulator Applet
An introduction to the Circuit Simulator Applet

III. Pre-lab Calculations. Show all work.

Step One: Determine total current I_{TOT} for the circuit of Figure 1.

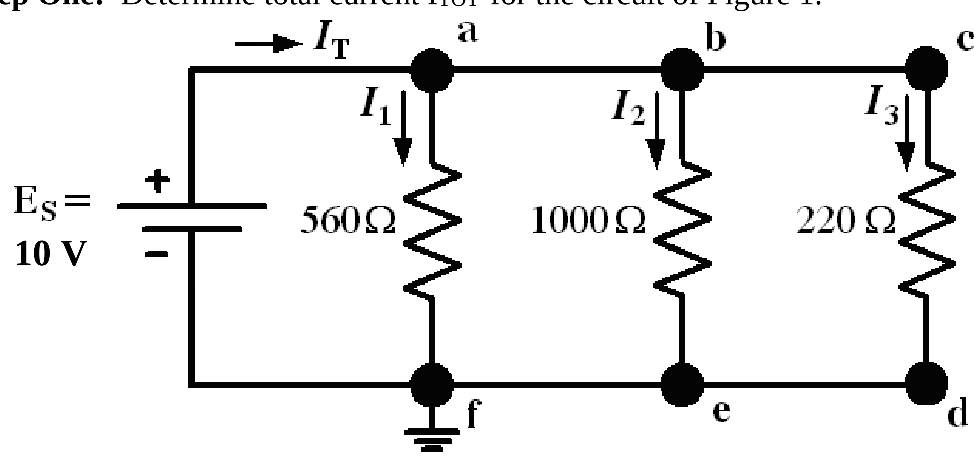

Figure 1

☐ Calculate the equivalent resistance, R_{EQ}, as seen by the source.

$R_{EQ(calculated)}$ = 136.4

☐ Calculate the total current I_T.

$I_{T(calculated)}$ = 147mA

Kirchoff's Current Law – Simulator Applet

Step Two: Branch Current Calculations

Use Ohm's Law to calculate the current down each branch.

$$I_x = \left(\frac{E_S}{R_x}\right)$$

I_X is the current through $\mathbf{R_X}$. Use nominal (expected) values of resistances.

$$I_1 = \left(\frac{E_S}{R_1}\right) = \left(\frac{\quad}{\quad}\right) =$$

I1= 17.9mA

$$I_2 = \left(\frac{E_S}{R_2}\right) = \left(\frac{\quad}{\quad}\right) =$$

I2= 10mA

$$I_3 = \left(\frac{E_S}{R_3}\right) = \left(\frac{\quad}{\quad}\right) =$$

I3= 45.5mA

Now use the Current Divider Rule to calculate the current values.

The current divider rule can be used to determine how current entering a node is split between the various parallel resistors connected to the node.

$$I_x = I_T\left(\frac{R_{EQ}}{R_x}\right)$$

I_X is the current through $\mathbf{R_X}$, $\mathbf{R_{EQ}}$ is the total resistance of parallel resistors, and I_T is the total source current entering the parallel circuit.

- ☐ Calculate the branch currents using the current divider rule, based upon your calculated values of I_T and R_{EQ}, and the nominal resistor values.

$$I_1 = I_T\left(\frac{R_{EQ}}{R_1}\right) = \qquad \left(\frac{\quad}{\quad}\right) =$$

I1= 17.9mA

$$I_2 = I_T\left(\frac{R_{EQ}}{R_2}\right) = \qquad \left(\frac{\quad}{\quad}\right) =$$

I2= 10mA

$$I_3 = I_T\left(\frac{R_{EQ}}{R_3}\right) = \qquad \left(\frac{\quad}{\quad}\right) =$$

I3= 45.5mA

Step Three: Verify Kirchhoff's Current Law (KCL).

Verify KCL by summing up the branch currents and comparing to the predicted total current from step one.

$$\sum I_{\text{entering node}} = \sum I_{\text{leaveing node}}$$

$$I_T = I_1 + I_2 + I_3$$

73.4mA = 45.5 + 10 + 17.9 = 73.4mA

How closely does the sum of currents entering the node match the sum leaving?

Exact X__________ **Very close**__________ **Very Different**_________

Step Four: Instructor or lab assistant verification that pre-lab calculations are complete.

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Kirchoff's Current Law – Simulator Applet

IV. Lab Procedure. Time Required: 35 minutes. **Check-off each step as you complete it.**

Step One: Construct a DC parallel circuit.

☐ In the Circuit Simulator Applet, construct the DC parallel circuit of figure 1. The suggested spacing of the layout below allows you to easily measure current through each parallel branch without rebuilding your circuit following each measurement.

NOTE: When constructing the wire connections, you need a separate wire to connect each node.

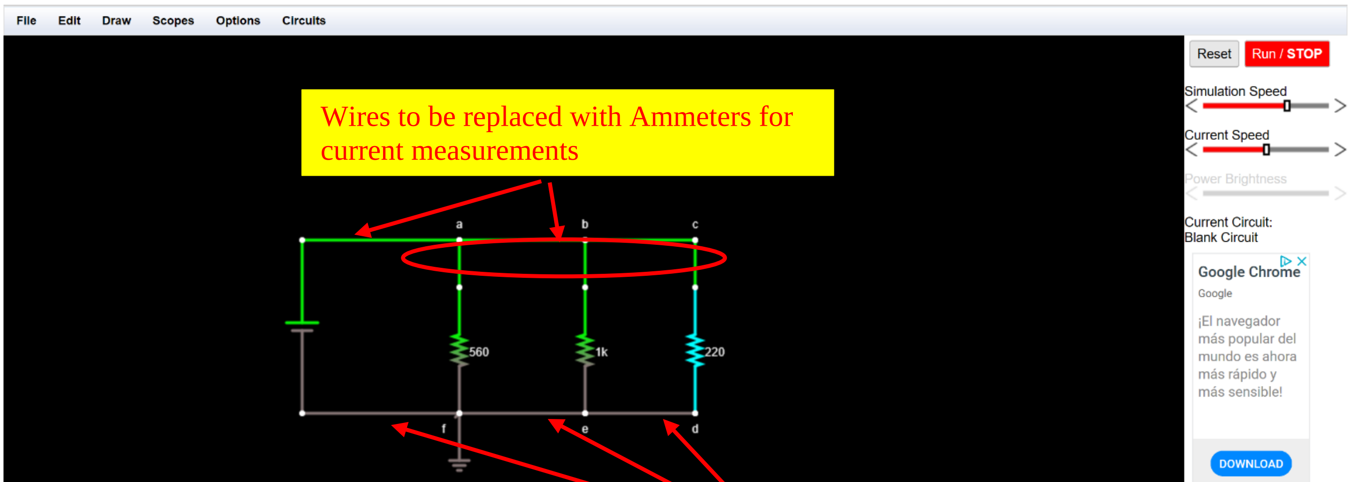

Figure 2

This is 3 separate wires. Not just one wire stretched across the whole bottom. Same with the top. See NOTE above.

☐ Set the DC power supply to 10 volts.

Step Two: Verify voltages of parallel elements.

Elements or branches are said to be connected in parallel when they have exactly two nodes in common, and therefore voltages across all parallel elements in a circuit will be the same.

☐ Measure the voltage drop across the voltage source and across each parallel branch.

E_S= 10V

V_{af}= 10V

V_{be}= 10V

V_{cd}= 10V

How closely do all the measured voltages match?

Exact X____ **Very close**____ **Very Different**____

Why? VDR

Step Three: Measure total and branch currents. Verify Kirchhoff's Current Law.

☐ Measure the total current and the current through each branch.

Remember the <u>current that you wish to measure must pass through the Ammeter</u>. This means you must insert an "OPEN" in the circuit, and measure current with the Ammeter wired into that opening. Figure 3 shows the measurement of the I_3 current through the 220 ohm resistor.

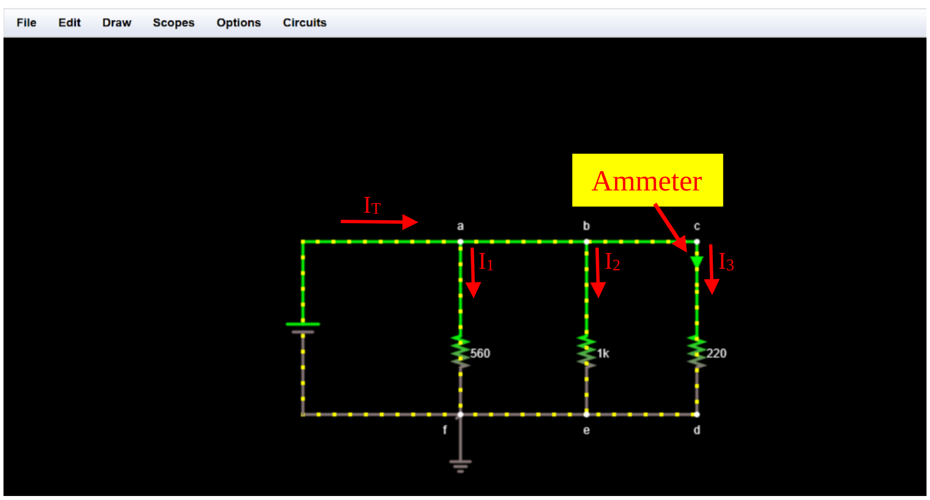

Figure 3

I_T= 73.31mA

I_1= 17.86mA

I_2= 10mA

I_3= 45.45mA

How closely do the measured branch currents match the predicted values from step two of the pre-lab calculations? <u>If they are substantially different, then you need to check your measurements or calculations for errors, and seek assistance from your instructor.</u>

Exact X____ **Very close**____ **Very Different**____

☐ Indicate on Figure 4 the direction of the DC currents in all branches and the polarity of the DC voltages across the voltage source and resistors.

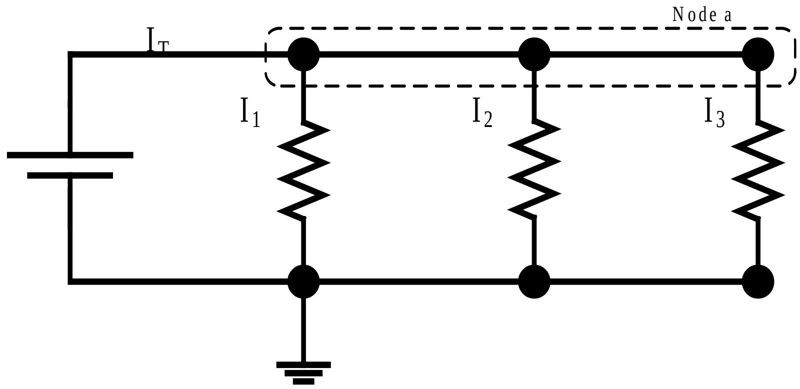

Figure 4

Kirchhoff's current law states that the summation of currents entering a node is equal to the summation of currents leaving that node.

☐ Verify Kirchhoff's Current Law for Node a in the above figure (calculations are required).

$$\sum I_{\text{entering node}} = \sum I_{\text{leaving node}}$$

$$I_T = I_1 + I_2 + I_3$$

73.4 = 17.9 + 10 + 45.5 = 73.4

How closely does the sum of currents entering the node match the sum leaving?

Exact X **Very close**__________ **Very Different**__________

Step Four: Resistors in parallel.

☐ Measure the equivalent resistance $\boldsymbol{R}_{\mathbf{EQ}}$, as seen by the source. <u>Ensure that you disconnect the power supply</u> before measuring the resistance.

$\boldsymbol{R}_{\mathbf{EQ(measured)}}$ = 136.4

How closely does the measured equivalent resistance match the predicted value from step one of the pre-lab calculations?

Exact X **Very close**__________ **Very Different**__________

For this parallel circuit, how does the size of $\boldsymbol{R}_{\mathbf{EQ}}$ compare with the sizes of the other resistors in the circuit?

Larger__________ **Smaller** X **Same**__________

From this practical exercise, what observation can we make about the relative values of resistance and the current flow through resistors? (Think of the phrase, "the path of least resistance".)

Since voltage drop is constant across resistors in parallel, the lower resistance paths will receive higher current, while higher resistance experiences less current

Step Five: Circuit Submission

- ☐ If required by your instructor, save the circuit to your computer and submit the circuit text file to your instructor for lab credit.