**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.**

*Keysight 34450A Digital Multimeter (DMM)*

*Agilent E3620A Dual DC Power Supply*

560 Ohm, 1000 Ohm, 220 Ohm resistor

**III. Pre-lab calculations. Show all work.**

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

\[
E_S = 10 \text{ V} \nonumber
\]

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

\[R_{EQ}(\text{calculated}) = \ldots\]

- Calculate the total current $I_T$.

\[I_T(\text{calculated}) = \ldots\]
Kirchoff’s Current Law

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 \( R_x \). Use nominal (expected) values of resistances.

\[ I_1 = \left( \frac{E_S}{R_1} \right) = \text{_________} = I_1 = \text{_________} \]

\[ I_2 = \left( \frac{E_S}{R_2} \right) = \text{_________} = I_2 = \text{_________} \]

\[ I_3 = \left( \frac{E_S}{R_3} \right) = \text{_________} = I_3 = \text{_________} \]

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 \( R_x \), \( R_{EQ} \) is the total resistance of parallel resistors, and \( I_T \) is the total source current entering the parallel circuit.

\[ \square \] 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.

\[ I_1 = I_T \left( \frac{R_{EQ}}{R_1} \right) = \text{_________} = I_1 = \text{_________} \]

\[ I_2 = I_T \left( \frac{R_{EQ}}{R_2} \right) = \text{_________} = I_2 = \text{_________} \]

\[ I_3 = I_T \left( \frac{R_{EQ}}{R_3} \right) = \text{_________} = I_3 = \text{_________} \]


Verify KCL by summing up the branch currents and comparing to the predicted total current from step
Kirchoff’s Current Law

one.

\[
\sum I_{\text{entering node}} = \sum I_{\text{leaving node}}
\]

\[
I_T = I_1 + I_2 + I_3
\]

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

Exact__________ Very close__________ Very Different_________

**Step Four:** Instructor or lab assistant verification that pre-lab calculations are complete.
Kirchoff’s Current Law

IV. Lab Procedure. Time Required: 40 minutes. Check-off each step as you complete it.

Step One: Construct a DC parallel circuit.

☐ On a QUAD board 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.

☐ Set the DC power supply to 10 volts. Verify the output of the power supply is accurate by measuring it with a DMM and adjusting the voltage as necessary.

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.

\[ E_S = \underline{} \]

\[ V_{af} = \underline{} \]

\[ V_{be} = \underline{} \]

\[ V_{cd} = \underline{} \]

How closely do all the measured voltages match?

Exact \[ \underline{} \]

Very close \[ \underline{} \]

Very Different \[ \underline{} \]

Why? \[ \underline{} \]
Kirchhoff’s Current Law

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

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

Remember the current that you wish to measure must pass through the DMM. This means you must insert an “OPEN” in the circuit, and measure current with the DMM wired into that opening. Figure 2 shows the measurement of the $I_3$ current through the 220 ohm resistor.

---

**CAUTION:**
IF YOU GET A YELLOW OVERLOAD LIGHT ON THE POWER SUPPLY, IT MEANS THAT YOU HAVE SHORTED ACROSS THE POWER SUPPLY WITH THE DMM.

---

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

- Exact________
- Very close________
- Very Different________

- Indicate on Figure 3 the direction of the DC currents in all branches and the polarity of the DC voltages across the voltage source and resistors.

---

**Figure 2**

*Figure 3*
Kirchoff’s Current Law

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

\[ \sum I_{\text{entering node}} = \sum I_{\text{leaving node}} \]
\[ I_T = I_1 + I_2 + I_3 \]

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

 Exact ________  Very close ________  Very Different ________

Step Four: Resistors in parallel.

 Measure the equivalent resistance \( R_{EQ} \), as seen by the source. Ensure that you disconnect the power supply before measuring the resistance.

 \( R_{EQ(\text{measured})} = \) __________

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

 Exact ________  Very close ________  Very Different ________

For this parallel circuit, how does the size of \( R_{EQ} \) compare with the sizes of the other resistors in the circuit?

 Larger ________  Smaller ________  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”.)

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________