

Name _____ Lab Section _____ Date _____

INTRODUCTION:

If resistors are placed so that they share the same two nodes, they form a **parallel circuit**. Since the resistors share the same nodes they must have the same voltage across them. In Figure 3.1, the voltage source V_s shares nodes **a** and **b** with both resistors. Even though the resistors share the same voltage, the current through each resistor can be different based on the value of each resistor.

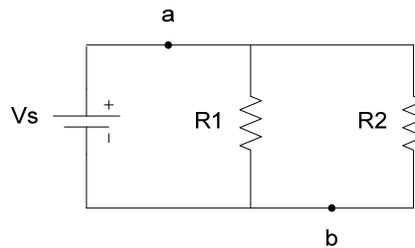


Figure 3.1: Parallel circuit.

As a reminder, each node spans all the metal making the interconnection of the circuit components. The bold lines in Figure 3.2 should drive this concept home.

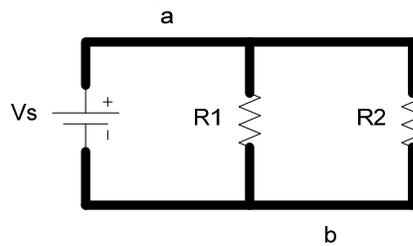


Figure 3.2: Parallel circuit showing each

The voltage V_{ab} is the same voltage as the source V_s . The current in each resistor (referred to as the branch current) can be calculated using Ohm's law. I_1 can be found by dividing V_{ab} by R_1 . Likewise I_2 can be found by dividing V_{ab} by R_2 .

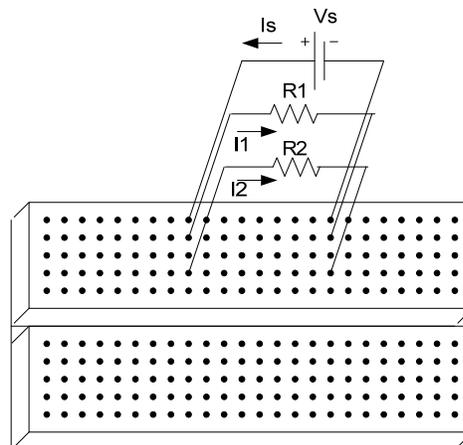


Figure 3.3: Parallel circuit on a protoboard.

The current I_s from the voltage source enters the parallel resistors and splits into the currents I_1 and I_2 according to the corresponding resistor values. Once each current passes through its resistor, the currents recombine back into the original current. Kirchhoff Current Law (KCL) states the sum of currents at a node is zero. Or said differently, the currents into a node equal the currents out of a node. Using KCL in the circuit above, the source current equals the sum of the branch currents ($I_s = I_1 + I_2$).

Finally, as a reminder, when asked to compare values, such as A (measured) with B (nominal), the preferred method is:

$$Rd = \frac{A - B}{B} \times 100\% = \frac{\text{measured} - \text{nominal}}{\text{nominal}} \times 100\% .$$

Simpson 260-8 Analog Multi-meter

The Simpson 260 analog meter is shown in Figure 3.4. The Simpson meter can be used to measure DC voltage over an extensive range. The sensitivity (S) of the meter is a way of expressing the internal resistance (R_{internal}) of the meter for each selector range. The resistance of the meter is equal to the sensitivity multiplied by the full scale voltage (V_{fs}) range.

$$R_{\text{internal}} = S \cdot V_{fs}$$

If the meter is set to the 10 V range, the internal resistance of the meter would be:

$$(20,000 \Omega/V)(10V)=200 \text{ k}\Omega.$$

Table 3.1: Simpson 260-8XPI Internal Resistance Specifications

Selector	Range	Sensitivity
DC Volts	0-1-2.5-10-25-50-250-500-1000 V	20,000 Ω/V
DC Millivolts	0-250 mV	20,000 Ω/V

To measure DC voltage using the Simpson meter:

- 1) Connect a black probe lead to the terminal labeled COMMON. Connect a red probe lead to the (+) terminal to the right of common.
- 2) Turn the left selector knob to +DC.
- 3) Turn the center main selector knob to the appropriate voltage scale.
- 4) Place one probe on each side of the resistor while the resistor is held firmly in place on the proto-board. Then read the DC voltage on the bottom of the top black scale.
- 5) Unlike resistance measurements, it is not necessary to multiply by a scaling factor nor is it necessary to “zero out” the meter.
- 6) When finished taking measurements, turn the right-hand, range selector switch to the OFF position.



Figure 3.4: Simpson 260-8XPI

To measure DC current using the Simpson meter:

- 1) Set the function select switch to +DC.
- 2) Connect a black probe lead to the terminal labeled COMMON.
- 3) If measuring current in the 0-50 μA range, connect a red probe lead to the +10A/50 μA /250mV terminal and set the main selector knob to the 50 μA setting.
If measuring current in in the 0-1-10-100-500 mA ranges, connect a red probe lead to the positive terminal (+) right and set the main selector knob to the 1 mA, 10mA, 100mA, or 500 mA setting.
If the expected range of the currents to be measured is unknown, it is safer to start at the higher scales and, if necessary, reduce the scale down to the best range to measure the current.
- 4) Break the circuit and insert the meter in series with current being measured.
If the current is larger than the scale, the reset button might pop out. If this occurs, change the main selector knob to a higher current range and push the reset button back in.

Agilent U1242B Digital Multi-meter

The Agilent U1242B digital multi-meter (DMM) is shown in Figure 3.5. The Agilent DMM can measure DC voltage, DC current, AC voltage, AC current, DC resistance, capacitance, conductance, continuity, voltage in dB, frequency in Hz up to 1MHz, duty cycle, and pulse width. The meter has an 11,000 count display which translates to 4 digits.

The Agilent DMM will be used in this laboratory exercise to measure DC voltage. The resolution and accuracy is outlined in Table 3.2 below. The accuracy is the percent of reading plus the number of least significant digits.

Table 3.2: Agilent U1242B Resistance Specifications

Range	Resolution	Accuracy
1000.0 mV	0.1 mV	0.09%+ 5
10.000 V	0.001 V	0.09%+ 2
100.00 V	0.01 V	0.09%+ 2
1000.0 V	0.1 V	0.15%+ 5

To measure DC voltage using the Agilent U1242B:

- 1) Connect a black probe lead to the black COM terminal and connect a red probe lead to the red V- Ω terminal.
- 2) Turn the main selector switch clockwise to the V= setting.
- 3) Place one probe on each side of the resistor. Then read the LCD display and note the units to the right of the numbers.
- 4) When finished taking measurements, turn the main selector switch to the OFF position.

To measure DC current using the Agilent U1242B:

- 1) Connect a black probe lead to the black COM terminal and connect a red probe lead to the red μA mA terminal.
- 2) Turn the main selector knob to either the μA or mA setting.
- 3) Break the circuit and insert the meter in series with the current being measured.



Figure 3.5: Agilent U1242B

PROCEDURE:

1. Construct on the protoboard the parallel circuit shown in Figure 3.6 using a source voltage of $V_s=10V$ (set the CC limit to 125mA) and the following resistors:

$R_1=510 \Omega$, $R_2=1 \text{ k}\Omega$, $R_3=10 \text{ k}\Omega$, $R_4=100 \text{ k}\Omega$, $R_5=1 \text{ M}\Omega$

2. Using the Agilent 34401a, the Agilent U1242B, and then the Simpson 260-8 measure the voltages V_s and V_{ab} followed by the branch currents (remember to break the circuit and to move the lead position on the meter to Amps). Record the measurement in Table 3.3.

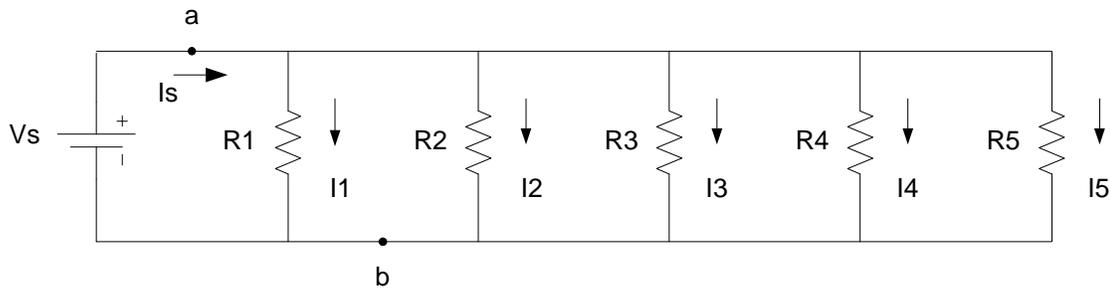


Figure 3.6: Parallel circuit.

CAUTION! The resistor R1 might get very hot to the touch!

(Have your instructor check you previous results before completing these steps)

3. Construct on the protoboard the series-parallel circuit shown in Figure 3.7 using a source voltage of $V_s=10V$ and the following resistors:

$R_1=10 \text{ k}\Omega$, $R_2=10 \Omega$, $R_3=100 \Omega$

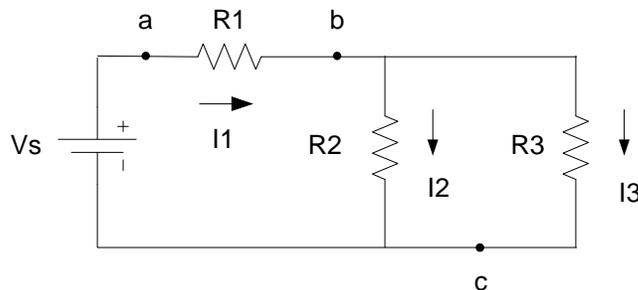


Figure 3.7: Series-Parallel circuit.

4. Using the Agilent 34401a, the Agilent U1242B, and then the Simpson 260-8 measure the voltages V_s , V_{ab} , and V_{bc} , followed by each of the branch currents (remember to break the circuit and to move the lead position on the meter to Amps). Record the measurement in Table 3.4.

- Use the data taken with the Agilent 34401a as the nominal values and calculate the error of the Agilent U1242B and the Simpson 260-8 of the measurements of the Series-Parallel circuit.

Table 3.7: Agilent U1242B Error of the Series-Parallel Circuit of Figure 3.7

Meter	V_s	V_{ab}	V_{bc}	I_1	I_2	I_3
Agilent 34401a (nominal values)						
Agilent U1242B (measured values)						
Rd (%)						

Table 3.8: Simpson 260-8 Error of the Series-Parallel Circuit of Figure 3.7

Meter	V_s	V_{ab}	V_{bc}	I_1	I_2	I_3
Agilent 34401a (nominal values)						
Simpson 260-8 (measured values)						
Rd (%)						

- Qualitatively compare the accuracy of measure using the Simpson 260 and the Agilent U1242B.

- Calculate the power dissipated by the resistor R_1 of the parallel circuit of Figure 3.6.

- Calculate the theoretical currents I_1 , I_2 , and I_3 that should flow in the series-parallel circuit of Figure 3.7.

Name: _____ Approved by: _____ Date: _____