Equivalent Resistances in Circuits

Object: This lab will focus onto simplify circuits that have resistors in series, parallel, or some other combination. You will compare experimentally measured $R_{\text{Equivalent}}$ with the calculated value.

Apparatus: AC/DC electronics lab board, resistors, and multimeter.

Introduction: When resistors are connected in parallel or in series, conceptual they act like a single resistor. Thus, one can replace the combination of resistors by a single resistor ($R_{\text{Equivalent}}$) which can greatly simplify the circuit and your calculations.

The rule for combining $n$ resistors in series is:

$$R_{\text{Equivalent}} = \sum_{i=1}^{n} R_i.$$ 

The rule for combining $n$ resistors in parallel is:

$$\frac{1}{R_{\text{Equivalent}}} = \sum_{i=1}^{n} \frac{1}{R_i}.$$ 

Procedure: Choose three resistors that have at least two different values. All the values of the resistors should be with a factor of 100 of each other (example: 2,200 $\Omega$, 4,300 $\Omega$, and 500 $\Omega$. To determine the resistance of each resistor, use the color coded printed on the outside surface.

Enter the information on the three chosen resistors below. In addition, use the multimeter to measure the resistance of each resistor and check whether the color coded value is within tolerance.
Table I

<table>
<thead>
<tr>
<th></th>
<th>1&lt;sup&gt;st&lt;/sup&gt;</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt;</th>
<th>3&lt;sup&gt;rd&lt;/sup&gt;</th>
<th>Coded Resistance</th>
<th>Tolerance</th>
<th>Measured Resistance</th>
<th>Discrepancy Significant?</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Connect the three resistors in series as shown in Figure 1. The order is unimportant. Using the multimeter, measure the equivalent resistance over all three resistors ($R_{123}$). Does the equivalent resistance follow the rule mentioned in the Introduction?

![Resistors in series](image.png)

Figure 1: Resistors in series.
Connect the three resistors in parallel as shown in Figure 4.2. The order is unimportant. Using the multimeter, measure the equivalent resistance over all three resistors (R_{12}). Does the equivalent resistance follow the rule mentioned in the Introduction?

![Figure 2: Resistors in parallel.](image)

Connect the three resistors in the combination as shown in Figure 4.2. The order is important. Using the multimeter, measure the equivalent resistance over all three resistors (R_{123}). How do you calculate the equivalent resistance for this case? Hint: break the problem into two steps, one where you combine resistors in series and one where you combine them in parallel.

![Figure 3: Combination of resistors.](image)

**The Laboratory Report:** Fill-out the template for this lab. For the three resistors in series and resistors in parallel, determine the uncertainty for the calculated R_{eqv}. Use the color coded tolerances for the uncertainty of each individual resistor.