I) Pre-lab Assignment (Do your work using the worksheet provided at the end of the handout)

a) For the circuit illustrated, compute the current in mA through $R_2$ as $V_1$ and $V_2$ vary independently between 0 and 6 V in 1.5-V steps. Put your results in a table like the one shown. The computation may be done with either a calculator or by PSPICE.

\[ R_1 = 470, \quad R_3 = 2.0K, \quad R_2 = 10^{N/12}, \quad \text{where} \quad N = \text{sum of last digit of each lab team member’s student ID number.} \quad (\text{Thus, } N \text{ can range from 0 to 18 for a two-student team and 0 to 27 for a three-student team.}) \quad \text{The computation of } R_2 \text{ is rounded to the nearest standard resistor value in the 12-point logarithmic sequence.} \]

\[
\begin{array}{cccccc}
V_1 & 0.0 & 1.5 & 3.0 & 4.5 & 6.0 \\
0.0 & & & & & \\
1.5 & & & & & \\
V_2 & 3.0 & & & & \\
4.5 & & & & & \\
6.0 & & & & & \\
\end{array}
\]

b) In the circuit below, there exists a coefficient $\alpha$ such that if $V_2 = \alpha V_1$, the voltage $V_x$ is zero for all values of $V_1$. Use superposition to determine analytically the value of $\alpha$.

\[
R_1 = 3.3K \quad \quad R_2 = \text{the same as in part (a)} \quad \quad R_3 = 15K
\]
II) Laboratory experiments

Part a)
1) Obtain the resistors needed to build the circuit.
2) Measure each of the resistance values using the multimeter and make a table containing the nominal and measured values of the resistors with %error.
3) Build the circuit on a breadboard.
4) Measure and record the current through $R_2$ as $V_1$ and $V_2$ vary independently from 0 to 6 V in 1.5-V steps. In other words, fill in a table like that in the pre-lab with measured values. Be as accurate as possible in setting the voltages.

Part b)
1) Obtain the resistors needed to build the circuit.
2) Measure each of the resistance values using the multimeter and make a table showing the nominal and measured value of each with %error.
3) Build the circuit on the breadboard.
4) Set one power supply ($V_1$) one step at a time to 0.5, 1, 2, and 4 V. At each voltage, adjust $V_2$ to obtain zero volts across $R_3$. Record the values of $V_1$ and $V_2$ and compute $\alpha$ for each step.

III) Demonstration of Superposition

[This section describes some data manipulation that will be done after the laboratory to fill a table for item 8 in part (a) of the lab report.]

The first column of the measured data in part (a) shows the dependence of the current on $V_1$ with $V_2$ set to zero. Similarly, the first row records the current produced solely by $V_2$ because $V_1$ has been set to zero. If superposition holds, then it should be possible to predict the response to any measured pair of $V_1$ and $V_2$ values just by adding the appropriate numbers in the first column and first row together. For example, to predict the current when $V_1 = 3$ and $V_2 = 4.5$ V, one could add the current measured with $V_1 = 3$ and $V_2 = 0$ from the first column to the current measured with $V_1 = 0$ and $V_2 = 4.5$ from the first row. In this way, it would be possible to fill every cell in the table using only the measured values from the first row and the first column, and that is what is asked for in item 8 of part (a) of the lab report.

IV) Lab Report

The lab report should be in standard format with a purpose and a conclusion section and contain the following specific items relating to the two experiments:

Part a)
1) Model numbers of all test equipment used
2) Block diagram of test set up
3) Circuit schematic
Experiment 2

4) Table of measured versus nominal value for each resistor including %error.
5) Table of computed current versus \( V_1 \) and \( V_2 \) from the pre-lab.
6) Table of measured current versus \( V_1 \) and \( V_2 \).
7) Table versus \( V_1 \) and \( V_2 \) of the computed error in percent between the measured and the computed values.
8) Table versus \( V_1 \) and \( V_2 \) built by superposition from the measured results. (See explanation on previous page.)
9) Table versus \( V_1 \) and \( V_2 \) containing %difference computed by comparing the results in item 8 with those in item 6.

Part b)
1) Model numbers of all test equipment used
2) Block diagram of test set up
3) Circuit schematic
4) Table of measured versus nominal value for each resistor including %error.
5) Record of the voltages pairs \((V_1, V_2)\) that set \( V_x = 0 \) with the computed corresponding \( \alpha \).
6) Comparison (%error) of the experimental \( \alpha \) values at each step with the theoretical value computed in the pre-lab.

&&&&&&&&&&&&&&&&&
(a) Complete the table below with the value of the current through R₂ as both V₁ and V₂ vary from 0 to 6 volts. The computations can be done using hand calculations or the DC SWEEP feature of PSPICE. Don’t forget to attach the PSPICE output plot.

<table>
<thead>
<tr>
<th>V₂</th>
<th>0.0</th>
<th>1.5</th>
<th>3.0</th>
<th>4.5</th>
<th>6.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>V₁</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Use the space below to determine analytically the value of α by using Superposition.