**A-4-(2).**

**Series-Parallel Combination Circuits**

**OBJECTIVES:**

After performing this experiment, you will be able to:

1. Use the concept of equivalent circuits to simplify series-parallel circuit analysis.

2. Compute the currents and voltages in a series-parallel combination circuit and verify your computation with circuit measurements.

**READING:**

Electric Circuits, Sections 3

**MATERIALS NEEDED:**

Resistors:

One 2.2 kΩ, one 4.7 kΩ, one 5.6 kΩ, one 10 kΩ

**SUMMARY OF THEORY:**

Most electronic circuits are not just series or just parallel circuits. Instead, they may contain combinations of components. Many circuits can be analyzed by applying the ideas developed for series and parallel circuits to them. Remember that in a series circuit the same current flows through all components and that the total resistance of series resistors is the sum of the individual resistors. By contrast, in parallel circuits, the applied voltage is the same across all branches and the total resistance is given by the reciprocal formula.

|  |  |
| --- | --- |
| Z:\임시 인터넷 파일\Content.Word\figure10-1_1.jpg | Z:\임시 인터넷 파일\Content.Word\figure10-1_2.jpg |
| **Figure 1** | |

In this experiment, the circuit elements are connected in composite circuits containing both series and parallel combinations. The key to solving these circuits is to form equivalent circuits from the series or parallel elements. You need to recognize when circuit elements are connected in series or parallel in order to form the equivalent circuit. For example, in Figure 1 (a) we see that the identical current is in both R2 and R3. We conclude that these resistors are in series and could be replaced by an equivalent resistor equal to their sum. Figure 1(b) illustrates this idea. The circuit has been simplified to an equivalent parallel circuit. After finding the currents in the equivalent circuit, the results can be applied to the original circuit to complete the solution.

The answer to two questions will help you identify a series or parallel connection: (1) Will the identical current go through both components? If the answer is yes, the components are in series. (2) Are both ends of one component connected directly to both ends of another component? If yes, the components are in parallel. The components that are in series or parallel may be replaced with an equivalent component. This process continues until the circuit is reduced to a simple series or parallel circuit. After solving the equivalent circuit, the process is reversed in order to apply the solution to the original circuit. This idea will be studied in this experiment.

**PROCEDURE:**

1. Measure and record the actual values of the four resistors listed in Table 1.

2. Connect the circuit shown in Figure 2. Notice that the identical current is through R1 and R4, so we know that they are in series. has both ends connected directly to , so these resistors are in parallel.

|  |
| --- |
|  |
| **Figure 2** |

3. You can begin solving for the currents and voltages in the circuit by replacing resistors that are either in series or in parallel with an equivalent resistor. In this case, begin by replacing and with one equivalent resistor. Label the equivalent resistor . Draw the equivalent series circuit in the space provided in the report. Show the value of all components, including .

4. The equivalent circuit you drew in step 3 is a series circuit. Compute the total resistance of this equivalent circuit and enter it in the first two columns of Table 2. Then disconnect the power supply and measure the total resistance to confirm your calculation. Enter the measured total resistance, ，in column 3.

5. The voltage divider rule can be applied directly to the equivalent series circuit to find the voltages across , and . Find , and using the voltage divider rule. Tabulate the results in Table 2 in the *Voltage Divider* column.

6. Find the total current, in the circuit by substituting the total voltage and the total resistance into Ohm’s law. Enter the computed total current in Table 2 in the *Ohm’s law* column.

7. In the equivalent series circuit, the total current is through , and . The voltage drop across each of these resistors can be found by applying Ohm’s law to each resistor. Compute , , and using this method. Enter the voltages in Table 2 in the Ohm’s law column.

8. Use and Ohm’s law to compute the current in R2 and R3 of the original circuit. Enter the computed current in Table 2. As a check, verify that the computed sum of and is equal to the computed total current.

9. Measure the voltages , , and . Enter the measured values in Table 2.

10. Change the circuit to the circuit shown in Figure 3. In the space provided in your report, draw an equivalent circuit by combining the resistors that are in series. Enter the values of the equivalent resistors on your schematic drawing and in Table 3.

|  |
| --- |
|  |
| **Figure 3** |

11. Compute the total resistance, , of the equivalent circuit. Then apply Ohm’s law to find the total current . Enter the computed resistance and current in Table 3.

12. Complete the calculations of the circuit by solving for the remaining currents and voltages listed in Table 3. Then measure the voltages across each resistor to confirm your computation.

|  |  |
| --- | --- |
| **Report for**  **Experiment A-5** | **Name**  **Date**  **Class** |

**ABSTRACT:**

**DATA:**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  | | --- | --- | --- | | **Table 1** | | | | Component | Listed  Value | Measured  Value | |  | 2.2 kΩ |  | |  | 4.7 kΩ |  | |  | 5.6 kΩ |  | |  | 10.0 kΩ |  | | |
| |  | | --- | | **Step 3 Equivalent Series Circuit** | |  | | |  |  |  |  | | --- | --- | --- | --- | | **Table 2** | | | | |  | Computed | | Measured | | Voltage Divider | Ohm’s  Law | |  |  |  |  | |  |  |  |  | |  |  |  |  | |  |  |  |  | |  |  |  |  | |  |  |  |  | |  |  |  |  | |  | 12.0 V | 12.0 V |  | |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | | **Step 10 Equivalent Circuit** | |  | | |  |  |  | | --- | --- | --- | | **Table 3** | | | |  | Computed | Measured | |  |  |  | |  |  |  | |  |  |  | |  |  |  | |  |  |  | |  |  |  | |  |  |  | |  |  |  | |  |  |  | |  |  |  | |

**RESULTS AND CONCLUSION:**

**EVALUATION AND REVIEW QUESTIONS:**

1. The voltage divider rule was developed for a series circuit, yet it was applied to the circuit in Figure 2.

(a) Explain.

(b) Could the voltage divider rule be applied to the circuit in Figure 3? Explain your answer.

2. As a check on your solution of the circuit in Figure 3, apply Kirchhoff’s voltage law to each of two separate paths around the circuit. Show the application of the law.

3. Show the application of Kirchhoff’s current law to the junction of and of the circuit in Figure 3.

4. In the circuit of Figure 3, assume you found that was the same as the current in and .

(a) What are the possible problems?

(b) How would you isolate the specific problem?

5. The circuit in Figure 6 has three equal resistors.

(a) If the voltmeter reads 4-8.0 V, find the voltage drop across . =

(b) What is the source voltage? Vs =

|  |
| --- |
|  |
| **Figure 6** |

6. What basic rules determine if two resistors in a series-parallel combination circuit are connected in series or in parallel?