# **PEEE I Practical Session 6**

Parallel DC Circuit

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**1. OBJECTIVE**

* To verify that the voltage and currents in a given parallel dc circuit obey Ohm’s law, Kirchhoff’s current law and the current divider rule.

**2. EQUIPMENT**

* DC power supply
* Digital Multimeters (DMMs)
* Training kit with 1 k3.3 k and k

**3. PROCEDURE**

3.1 Use **resistor colour codes** to identify the 1 k3.3 kandkresistors on the transparent component board (training kit).

**Do not rely** on the resistor **labels** on the component board to identify these 3 resistors.

**Do not connect** the **circuit** in Figure 6.1 now.

3.2 Pick up the **DMM** labelled **‘Voltmeter’** and turn its **rotary switch to ‘'** for measuring resistance. **Connect the DMM across *R*1** to measure its actual resistance. **Fill in** the measured resistance in **Column B** of **Table 6.1**.

 Repeat step 3.2 to measure and record the actual resistances of *R*2 and *R*3 in Table 6.1.

|  |  |  |  |
| --- | --- | --- | --- |
|  | *A* | *B* | *C* |
| Resistor Label | Nominal Resistance indicated by colour code | Actual/Measured Resistance | Resistance calculated by using measured voltage, measured current, and Ohm’s law |
| *R*1 | 1.0 kΩ | kΩ | *V*S / *I*1 = kΩ |
| *R*2 | 3.3 kΩ | kΩ | *V*S / *I*2 = kΩ |
| *R*3 | 6.8 kΩ | kΩ | *V*S / *I*3 = kΩ |
| *R*T | ― | kΩ | *V*S / *I*T = kΩ |
| Are the calculated resistances using Ohm’s law in Column C close to the actual resistances in Column B?  Yes / No (Circle your answer) | | | |

# Table 6.1

Do not connect the circuit in Figure 6.1 now. Follow steps 3.1 to 3.4 to fill in Column B.

Before filling in Column C, follow steps 3.5 to 3.12 to fill in Table 6.2 first.

3.4 **Calculate** the total resistance with the **measured resistances**.  
**Record** your answer in **Table 6.1**.

**Note:**

The actual resistance should be within the manufacturing tolerance. For example, a gold coloured tolerance band indicates a tolerance range of ±5%. 1 k ±5% is a resistance range of 950 to 1050 .

In the PEEE experiments you can assume that the DMM resistance measurements are accurate.

3.5 Skip filling in the rest of Table 6.1 after completing Column B.

3.6 **Connect the circuit** shown in Figure 6.1. As you are not provided with 3 DMMs, **replace** the **second milliammeter** with a **short circuit** at this stage.

**X**

−

+

mA

−

+

mA

*V*S

≈ 5 V

−

+

−

+

**V**

*R*3

6.8 kΩ

*R*2

3.3 kΩ

*R*1

1.0 kΩ

Figure 6.1 A parallel circuit

3.7 Set the dc power **supply voltage *V*S** to about **5 V**.

3.8 Connect the **DMM** labelled **‘Voltmeter’** across the power supply to measure the **supply voltage *V*S**. Turn the **rotary switch** of the DMM to **Volt dc, ‘V**⎓**’**. Record your measurement in Table 6.2. Keep the supply voltage unchanged throughout the experiment.

**Note:**

You can safely assume that the **input resistance** of the **voltmeter** is **infinity** and the **input resistance** of the **ammeter** is **zero**. Therefore theoretically no current flows through the voltmeter, and the voltage drop across the ammeter is equal to zero.

3.9 Fill in the **theoretical** values for ***V*R1, *V*R2 and *V*R3** in Table 6.2 **according to** your measured supply voltage *V*s.

3.10 Use the other **DMM** labelled **‘Ammeter’** to measure the **total circuit current *I*T**. Turn the **rotary switch** to **mA dc, ‘mA**⎓**’**. Record the current value in Table 6.2.

3.11 Reconnect the **current meter** **in series** with *R*1 to measure *I*1. Turn the **rotary switch** to **μA dc, ‘μA**⎓**’**. Record the current value in units of mA in Table 6.2.

3.12 Repeat step 3.11 to measure and record *I*2 and *I*3.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Supply Voltage  *V*S (V) | Voltage (V) | | | Current (mA) | | | |
| *V*R1 | *V*R2 | *V*R3 | *I*T | *I*1 | *I*2 | *I*3 |
|  |  |  |  |  |  |  |  |

Table 6.2

3.13 Check whether the measured resistances, voltage and currents obey Ohm’s law.

**Complete Table 6.1** using the values recorded in Table 6.2.

3.14 Check whether the measured currents obey Kirchhoff’s Current Law (KCL).

The following equation is written by applying KCL at node ‘X’ in Figure 6.1.

Fill in Table 6.3 according to the measured currents recorded in Table 6.2.

|  |
| --- |
| Total current **entering** node ‘X’ *I*T = \_\_\_\_\_\_\_mA |
| Total current **leaving** node ‘X’ *I*1 + *I*2 + *I*3 = \_\_\_\_\_\_\_mA |
| Do the total current entering and leaving node ‘X’ obey Kirchhoff’s current law?  Yes / No (Circle your answer) |

# Table 6.3

3.15 Check whether the measured resistances and currents obey the Current Divider Rule (CDR).

**Copy** the measured currents *I*1, *I*2 and *I*3 **from Table 6.2** to Column A of Table 6.4.

**Calculate** *I*1, *I*2 and *I*3 using the current divider rule. **Use** the **measured resistances** in **Table 6.1** and the **measured total current** in **Table 6.2** for your calculation. Compare the measured *I*1, *I*2 and *I*3 with the calculated values.

|  |  |  |
| --- | --- | --- |
| Current | *A* | *B* |
| Measured Value in Table 6.2 | Calculated Value using CDR |
| *I*1 |  |  |
| *I*2 |  |  |
| *I*3 |  |  |
| Does the current divider rule give answers close to the measured values?  Yes / No (Circle your answer) | | |

Table 6.4

**Note:**

Calculations in Column B are based on multiple measured values. Therefore, the **direct measurements** of *I*1, *I*2 and *I*3 in **Column A** are **more accurate** than the calculated values in Column B.

|  |  |
| --- | --- |
|  | Does the inclusion of the voltmeter (DMM set to voltage mode) in the circuit affect the branch current measurements significantly? (Yes/No). Briefly explain your answer.  If the voltmeter is wrongly connected in series to a branch resistor, what will be the current in the resistor?  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**4. DISCUSSION**

4.1 The sum of the current flowing into a node is equal to

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ . This is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ law.

4.2 In a parallel circuit the voltage is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ across each component.

4.3 Write an equation to calculate the total resistance *R*T of three parallel resistors, *R*1, *R*2, and *R*3.

4.4 The total resistance of a parallel circuit is \_\_\_\_\_\_\_\_\_\_\_\_\_\_ than the smallest resistance in that circuit.

4.5 In a parallel circuit with 8 resistors connected in parallel, *R*1, *R*2, … *R*8, the current flowing through *R*8 can be calculated by either one of the following two equations:

**5. CONCLUSION**

The results of this experiment were found to obey the following circuit laws and rules: