**PEEE I Practical Session 7**

DC Circuit – Series-parallel Circuit

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**1. OBJECTIVES**

* To verify Kirchhoff’s Voltage Law (KVL), Kirchhoff’s Current Law (KCL), Current and Voltage Divider Rules for a series-parallel circuit

**2. MATERIALS NEEDED**

* DC power supply
* Digital Multimeters (DMMs)
* Resistors with values 1.0 k(x 2)3.3 kk k
* Notebook PC with NI Multisim Software

**3. PROCEDURE**

3.1 Connect the circuit as shown in Figure 7.1 below.

**a**

R2 (1.0 k

**c**

**b**

+

\_

R3

3.3 k

**(10 V)**

I4

I3

I5

R4

6.8 k

Figure 7.1: A series-parallel circuit

I1

I2

**VS**

R5 (10 k

**d**

R1 (1.0 k

I5

I5

3.2 Set the voltage (VS) from the dc power supply to 10 volts. A voltmeter (DMM set to ***voltage*** mode) connected across the supply is to monitor this source voltage.

3.3 Measure currents with another DMM (set to ***current*** mode). Record I1, I2, I3, I4 and I5 that flow through R1, R2, R3, R4 and R5 respectively in Table 7.1 on the next page.

Table 7.1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Supply Voltage  VS | Currents (mA) | | | | | Voltage Drops (V) | | | | |
| I1 | I2 | I3 | I4 | I5 | VR1 | VR2 | VR3 | VR4 | VR5 |
| 10 V |  |  |  |  |  |  |  |  |  |  |

3.4 Use DMM (set to ***voltage*** mode) to measure and record the voltage drops across each of the five resistors R1, R2, R3 R4 and R5 and tabulate the results in Table 7.1 above.

3.5 Calculate the actual resistance by calculating the ratio of voltage to current for each of them and comparing it with their rated value. The rated value is the value of the resistor read from its colour code.

|  |  |  |  |
| --- | --- | --- | --- |
| Resistor | (Ω) | Rated Resistance Value (Ω) | Actual Resistance |
| R1 |  | 1.0 kΩ |  |
| R2 |  | 1.0 kΩ |  |
| R3 |  | 3.3 kΩ |  |
| R4 |  | 6.8 kΩ |  |
| R5 |  | 10 kΩ |  |

Table 7.2

3.6 Kirchhoff’s Voltage Law (KVL)

3.6.1 Based on KVL, the voltage VS is equal to the sum of the total voltage drops across the complete circuit. Write down the KVL equation in terms of VS, Vab, Vbc and Vcd in the space below.

|  |
| --- |
| KVL equation: |

3.6.2 Referring to the schematic circuit diagram given in Figure 7.1 and based on measurements recorded in Table 7.1, extract the equivalent voltage drops for Vab, Vbc and Vcd and enter the values into Table 7.3 below.

|  |  |  |  |
| --- | --- | --- | --- |
| Supply Voltage VS | Vab | Vbc | Vcd |
| 10 V |  |  |  |

Table 7.3

3.6.3 Do the values in Table 74.3 conform to KVL? YES / NO

3.7 Kirchhoff’s Current Law (KCL)

Based on the circuit given in Figure 7.1, KCL equations at nodes “a” and “b” are given in Table 7.4 below. Extract the necessary current values from Table 7.1 to see whether your results conform to KCL.

|  |  |  |
| --- | --- | --- |
|  | KCL Equation | I5 = |
| Node “a” | I5 = I1 + I2 | I1 + I2 = |
| Node “b” | I5 = I3 + I4 | I3 + I4 = |

Table 7.4

Do the values in Table 7.4 conform to KCL? YES / NO

3.8 Voltage Divider Rule

Using this rule, calculate the values of voltages Vab, Vbc and Vcd. Check and confirm that these calculated values are very close to the measured ones tabulated in Table 7.3.

|  |  |
| --- | --- |
| Calculated Voltage Drops | Measured Voltage Drops |
|  | Vab = |
|  | Vbc = |
|  | Vcd = |

Table 7.5

3.9 Current Divider Rule

3.9.1 Calculate the theoretical total equivalent resistance by using the following formula:

|  |
| --- |
| ⇨RT = \_\_\_\_\_\_\_\_\_\_ |

3.9.2 Calculate the total current (I5) in the circuit by dividing the supply voltage with the theoretical total equivalent resistance.

|  |
| --- |
| ⇨I5 (*calculated*) = \_\_\_\_\_\_\_\_\_mA |

3.9.3 Based on the Current Divider Rule, calculate the values of I1, I2, I3 and I4 and check to confirm that the calculated values are very close to the measured ones tabulated in Table 7.1.

|  |  |
| --- | --- |
| Calculated Currents | Measured Currents |
|  | I1 = |
|  | I2 = |
|  | I3 = |
|  | I4 = |

Table 7.6

|  |  |
| --- | --- |
|  | What would happen to the total current in the series-parallel circuit if a series connected resistor is short-circuited? (Decreased/Increased/Zero). Why?  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**4. DISCUSSION**

If R3 develops a short-circuit fault, how would this affect the voltages: Vab, Vbc and Vcd; and currents: I1, I2, I3, I4 and I5?

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**5. CONCLUSION**

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