

**Birzeit University**

**Faculty of Engineering & Techonology**

**Department of Electrical & Computer Engineering**

**ENEE211**

**Lab Report Exp#2**

**“Short and opens in electrical circuits”**

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| **Abstract** |  |  |

**This experiment was done to verify KVL and KCL, voltage divider and current divider rules, and to examine the effect of short and open circuited resistor in electrical circuits by analyzing some circuits. It was verified that the sum of all voltages in a closed loop equals to zero, and the sum of currents entering a node equals the sum of currents leaving it. Also, it was verified that elements connected in series have the same current, and elements connected in parallel have the same voltage. However, the voltage in series connection, and the current in parallel connection are divided between the resistors with respect to their magnitude. Moreover, currents and voltages were examined when there were open and short circuits.**

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| **Theory** |  |  |

**In many time, when we need to make analysis’s for specific circuits, we need to obtain the value of the voltage not from the source only, but also across the element , therefore we try to make sense about the way to calculate it from the general source.**

**In the most case, the needed voltage is less than the voltage from the main source, so we can use the resistor in correct configuration to reduce the voltage from the power source.**

**So, in practical worlds of circuits, if we know the voltage across and the current through it –e.g element-we connect a small resistance-calculated by ohmic law- with the voltage source to drop some of the voltage.**

**But the last method dose not well work-expensive and not accurate-so we fined the voltage divider to make sense about this idea.**

**As we can see A more practical solution to the problem is to use two resistors in series, and use the voltage appearing across one of them. This configuration is known as a *voltage divider* because it divides the source voltage into two parts.**

**So,**

**V1dc = IR2+IR1→I = V1dc / (R1+R2)**

 **VR1 = IR1 = (V1.R1) / (R1+R2)**

 **VR2 = IR2 = (V1.R2) / (R1+R2)**

**That is the voltage divider formula.**

**The current divider:**

**This rule based on the voltages that equal in all branch of the circuits,-when we talk about current divider, that mean parallel configuration-so consider the circuits shown to the right. the current divider circuit consists of**

**current source with two resistors in parallel**

**V1 = I1\*R1 = I2\*R2 =**

 **Idc \*(R1.R2)/ (R1+R2)**

**→ I1 = Idc \*R2 / (R1+R2).**

**→I2 = Idc \* R1 / (R1+R2).**

**That is the current divider formula.**

**Another application in this experiment is the Potentiometer or Potentiometer as a voltage divider.**

**Its consist of resistor that we can make change for its value of the voltage on 3 ports as shown in the right fig, that we can change the voltage in the upper port and the lower port .to explain this, its a fixed value resistor with a third, movable slider, if we represent the position of The slider by z\_ where z varies between**

**0 and 1\_ the resistance between the lower**

**End of the resistor and the slider will be zR and**

 **Between the slider and the upper end will be**

**(1-z)R, where R is the total resistance of the**

**Potentiometer.**

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| **Procedure** |  |  |

**A power supply, a digital multimeter, and a variety of resistors were used.**

**1) Kirchhoff’s laws:**

**The circuit in figure (1) was connected,**

**and the power supply was set to 10 V.
Then, the voltage on each resistor was measured relative to the ground and the current in each branch was measured.**

** Figure (1)**

**2) Voltage divider:**

**The circuit in figure (2) was connected, and the power supply was set to 12V.**

**V1, V2 and V3 were measured relative to the ground. Then, R1 was shorted and the voltages at A, B and C were measured. The previous step was repeated for R2 and R3. Figure (2)**

**Then, R1 was removed (open circuit) and the voltages at A, B and C were measured. The previous step was repeated for R2, R3.**

**The circuit in figure (3) was connected.**

**The pot was changed until V0=3 V. Then**

**RAB and RBC were measured and recorded. Figure (3)**

**The circuit in figure (4) was connected.A variable resistor was used for RL. It was set to 1kΩ, 10kΩ, 100kΩ and then to ∞. V0 was measured for each value of RL.**

** Figure (4)**

**3) Current divider:**

**The circuit in figure (5) was connected and the power supply was set to 15 V. The values Is, I1, I2, I3, V1, and V2 were measured. After that, R1 was shorted and the same values were measured. The previous step was repeated for R2 and R3.Then R1 was removed (open circuit) and the same values were measured, and that was repeated for R2, R3.**

**4) Short and open circuited resistor in series-parallel circuits:**

**The circuit in figure (6) was connected, and the power supply was set to 12 V.**

**The voltages VA, VB, and VC were measured with respect to the ground. Then, R1 was shorted and the voltage values at A, B, and C were measured and recorded. The previous step was repeated for R2 and R3. After that R1 was removed (open circuit) and the voltage values at A, B, C were measured and recorded, and this step was repeated for R2 and R3.**

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| **Data** |  |  |

Part A:

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| --- | --- | --- |
| R(Ω) | Voltage | Current |
| 1.2k | V1=3.77 V | I1= 3.20 mA |
| 2.2k | V2=3.42 V | I2= 1.55 mA |
| 1k | V3=1.66 V | I3= 1.66 mA |
| 390 | V4=0.64 V | I3= 1.66 mA |
| 680 | V5=1.12 V  | I3= 1.66 mA |
| 820 | V6=2.59 V | I1= 3.20 mA |

Part B: a).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Voltage | Normal | R1 S/C | R2 S/C | R3 S/C |
| Measured | Measured | Calculated | Measured | Calculated | Measured | Calculated |
| Va | 11.93V | 11.89 V | 12.00 V | 11.89 V | 12.00 V | 11.89 V | 12.00 V |
| Vb | 4.22 V | 11.89 V | 12.00 V | 1.79 V | 1.807 V | 3.26 V | 3.26 V |
| Vc | 1.37 V | 3.86 V | 3.87 V | 1.79 V | 1.807 V | 0.00 V | 0.00 V |

b)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Voltage | Normal | R1 O/C | R2 O/C | R3 O/C |
| Measured | Measured | Calculated | Measured | Calculated | Measured | Calculated |
| Va | 11.98 V | 11.88 V | 12 V | 11.90 V | 12 V | 11.89 V | 12 V |
| Vb | 4.25 V | 0 V | 0 V | 11.90 V | 12 V | 11.89 V | 12 V |
| Vc | 1.37 V | 0 V | 0 V | 0 V | 0 V | 11.89 V | 12 V |

c)

$$R\_{AB}=7.23kΩ$$

$$R\_{BC}=2.50kΩ$$

d)

|  |  |
| --- | --- |
| RL | V0 |
| 1K | 2.04 V |
| 10K | 3.07 V |
| 50K | 3.20 V |
| 100K | 3.21 V |
| ∞ | 3.23 V |



Part C:

a)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Voltage | Normal | R1 S/C | R2 S/C | R3 S/C |
| Measured | Measured | Calculated | Measured | Calculated | Measured | Calculated |
| V1 | 13.30 V | 14.7V | 15 V | 14.7 V | 15 V | 14.7 V | 15 V |
| V2 | 1.31 V | 0 V | 0 V | 0 | 0 V | 0 V | 0 V |
| Is | 6.12 mA | 6.80 mA | 6.82 mA | 6.80 mA  | 6.82 mA | 6.80 mA | 6.82 mA |
| I1 | 1.62 mA | 6.7 mA | 6.82 mA | 0 mA | 0 mA | 0 mA | 0 mA |
| I2 | 1.1 mA | 0 mA | 0 mA | 6.80 mA | 6.82 mA | 0 mA | 0 mA |
| I3 | 3.40 mA | 0 mA | 0 mA | 0 mA | 0 mA | 6.80 mA | 6.82 mA |
| I23 | 4.50 mA | 0 mA | 0 mA | 6.80 mA | 6.82 mA | 6.80 mA | 6.82 mA |

b- **You said not to do it.**

Part D:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Voltage | Normal | R1 O/C | R2 O/C | R3 O/C |
| Measured | Measured | Calculated | Measured | Calculated | Measured | Calculated |
| Va | 12 V | 12.1 V | 12 V | 12.1 V | 12 V | 12.1 V | 12 V |
| Vb | 4.15 V | 0 V | 0 V | 4.28V | 4.87 V | 5.05 V | 5.53 V |
| Vc | 1.8 V | 0 V | 0 V | 1.39 V | 2.21 V | 1.25 V | 2.00 V |

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| --- | --- | --- | --- | --- |
| Voltage | Normal | R1 S/C | R2 S/C | R3 S/C |
| Measured | Measured | Calculated | Measured | Calculated | Measured | Calculated |
| Va | 12 V | 12.1 V | 12 V | 12.1 V | 12 V | 12.1 V | 12 V |
| Vb | 4.15 V | 12.1 V | 12 V | 1.83 V | 2.83 V | 1.84 V | 2.83 V |
| Vc | 1.8 V | 5.44 V | 6.99 V | 1.83V | 2.83 V | 1.82 V | 2.83 V |
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| **Conclusion** |  |  |

 **The main reason for this experiment was to prove the Kirchhoff’s voltage law and Kirchhoff’s current law, the method we used was building many different circuits and removing one load at a time or shortening them and then taking the voltage and current values around the circuit to verify the principles of KVL and KCL, for KCL states that the algebraic sum of all currents at any node in the circuit is equal to the algebraic sum of all current leaving it, and that’s what we proved throughout the experiment, and KVL states that the algebraic sum of all the voltages around any closed path is zero, and that’s what we proved with our measured values, by removing different resistances around the circuit however the voltage sum continued to be zero.**

 **However there were many miscalculations in the circuit for different reasons, some of them were due to the fact that mathematically we didn’t calculate the wires resistances, and also internal resistances of the voltage or current source, also the measurement tools and sources were not completely accurate, and couldn’t give the exact wanted values which effected the measured values by a small amount.**