German – Jordanian University (GJU)

Electrical Circuits 1 Laboratory

Section 3

Experiment 4

Potentiometers and the Wheatstone Bridge

Post lab Report

Mahmood Hisham Shubbak

Student number: 12

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Objectives:

✓ To learn about potentiometers and their use.
✓ To build a Wheatstone bridge to measure an unknown resistance.

Introduction and Theory:

- A potentiometer is a variable resistor consists usually of a turning dial to change the value of its resistance between two of its terminals.

- A Potentiometer -

- The resistance between the wiper (b) and either side of the outer terminals (a or c) varies from zero to a maximum of the full rating of the POT.

\[ R_{\text{max}} = R_{ac} = R_{ab} + R_{bc} \]

- A Wheatstone bridge is a circuit used to measure the resistance of an unknown resistor.

- In the Wheatstone bridge we adjust the value of POT (R3) until the voltage across a & b is zero, then we can calculate the unknown resistance Rx from this equation.

\[ R_x = \frac{R_1}{R_2} \times \frac{1}{R_3} \]
This experiment consists of two parts:

**Part A:**

**Procedure:**

1. Connect the circuit shown in the *figure 1*.

![Figure 1](image)

2. Measure $V_2$ for different values of $R_{pot}$.
3. Calculate $I_{pot}$ using Ohm's law.
4. Make a table of results and plot the current ($I$) vs. voltage ($V$) for $R_{pot}$.
5. Calculate the resistance from the curves.

**Results:**

- The results of this part are shown in this table:

<table>
<thead>
<tr>
<th>Resistance of $R_{pot}$</th>
<th>Voltage V (V)</th>
<th>Current I (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R(POT)1 = 4.94 , k\Omega$</td>
<td>2.35</td>
<td>0.476</td>
</tr>
<tr>
<td>$R(POT)2 = 10.07 , k\Omega$</td>
<td>2.63</td>
<td>0.261</td>
</tr>
</tbody>
</table>

- This graph below shows the current ($I$) vs. voltage ($V$) for $R_{pot}$.
From this graph $R_{pot1}=4.937 \, k\Omega$, and $R_{pot2}=10.06 \, k\Omega$

**Part B:**

**Procedure:**

1. Connect the circuit shown in the figure 2 on the bread board, with $R_1=3.3\, k\Omega$, $R_2=4.7\, k\Omega$, $Rx$ is an unknown resistance, $R_3$ is a potentiometer.

![Circuit Diagram](image)

2. Adjust the POT (R3) until $V_{ab}=0$.
3. Measure $R$ for POT.
4. Calculate $Rx$.
5. Measure $Rx$.
6. Calculate the %difference.

**Results:**

*When $V_{ab}=0$:*

- $R(POT)=0.948k\Omega$
- $Rx=0.666k\Omega=666\Omega$
- Measured value of $Rx=670\Omega$
- % difference=0.6%

**Discussion**

We can derive the equation: $Rx = \frac{R_1}{R_2} \cdot R_3$ as follows:

- when $V_{ab}=0$: $V_x=V_1$ and $V_2=V_3$ (*parallel*)
- when we multiply these two equations the result will be: $V_x \cdot V_2 = V_1 \cdot V_3$
- dividing this equation by $Ix \cdot I_1$ results in: $Rx \cdot R_2 = R_1 \cdot R_3$
- divide the equation by $R_2$, the result is $Rx = \frac{R_1}{R_2} \cdot R_3$
In this experiment (Part B) we had % difference in the value of \( R_x \); this might be because one of these reasons:

1. It is not easy to adjust the POT accurately.
2. The resistance of wires used to make the circuits.
3. The resistance of the used resistors was slightly less than its theoretical value.
4. Systematic errors.

**Conclusion**

- A potentiometer is a variable resistor

\[ R_{\text{max}} = R_{ac} = R_{ab} + R_{bc} \]

- A Wheatstone bridge is a circuit used to measure the resistance of an unknown resistor.

\[ R_x = \frac{R_1}{R_2} \cdot R_3 \]