Prelab 1
Resistance Measurements

a)  
1- Why the voltmeter must be connected in parallel?  
2- If the voltmeter is connected in series, why its reading will equal the reading of the power supply?  
3- Why the ammeter must be connected in series?  
4- What is the behaviour of the capacitor and inductor at dc?  

b)  
1- For the circuit shown in figure (1.1), if the power supply=10V, then compute the value of I(mA) for the R=2.2 KΩ, and record them in table (1.1).  
2- Compute the values of R (KΩ), and G (m moh), where  

\[ R = \frac{V}{I} \]  
\[ G = \frac{1}{R} \]  

Figure (1.1)

<table>
<thead>
<tr>
<th>R(KΩ)</th>
<th>V(v)</th>
<th>I(mA)</th>
<th>R(KΩ)</th>
<th>G(m moh)</th>
<th>% Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2.2</td>
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<tr>
<td>10</td>
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</tr>
</tbody>
</table>

Table (1.1)

3- Repeat steps 1 and 2, but use as source with v=5Vrms and f=500Hz.  

**Note:** Read the theoretical part of experiment (1) to be able to answer this part.
c)

Figure (1.2)

Fill in the spaces:
For the circuit shown in figure (1.2)
1- Wheatstone bridge measurements method is used to measure ___________ values of resistance because ________________.
2- At stability, if $R_1 > R_3$, then $R_{\text{unk.}} = \ldots R_{\text{var.}}$.
3- When the readings of voltmeter is zero, if $R_1 = R_3 = 1\, \text{K} \Omega$, $R_{\text{var.}} = 10\, \text{K} \Omega$, then $R_{\text{unk.}} = \ldots$.

d)
For the circuit shown in figure (1.3):

Figure (1.3)

Fill in the spaces:
1- At dc, inductor acts as a ___________ and the capacitor acts as a ___________, then the circuit shown in figure (1.3) may be considered as in figure ____________.
2- When the reading of voltmeter is zero, $R_1 = 1.8\, \text{K} \Omega$, $R_3 = 10\, \text{K} \Omega$, $R_{\text{var.}} = 10\, \text{K} \Omega$ then $R_{\text{unk.}} = \ldots$. 
Experiment 1
Resistance Measurements

Part A: Familiarization

Objective:
- To measure and calculate resistors by several methods.
- Discussing the behavior of capacitor and inductor in dc circuits.

Methods of calculating and measuring resistance:

I- By using OHM’s Law:

Experiment procedure:

a- Connect the circuit as shown in figure (1.1)

b- Set the power supply output voltage to 10v.

c- Record the value of I(ma) for R=1K, R=2.2K, and R=10K in table (1.1)

d- Compute the values of R(KΩ) using OHM Law, and G (m moh), and compute the percentage of error for the values of R, where the percentage of error can be computed as:

\[
% \text{Error} = \frac{|\text{true value} - \text{measured value}|}{\text{true value}} \times 100
\]

![Figure(1.1)](image)

<table>
<thead>
<tr>
<th>R(KΩ)</th>
<th>V(v)</th>
<th>I(mA)</th>
<th>R(KΩ)</th>
<th>G(m moh)</th>
<th>% Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2.2</td>
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<tr>
<td>10</td>
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</tbody>
</table>

Table (1.1)

II- By using ohmmeter:

1- Connect the circuit as shown in figure (1.2).

2- Measure the value of R (KΩ) directly by connecting the digital multimeter in parallel with the resistor and using it as an ohmmeter.

3- Record the value of R (KΩ) and compute the percentage of error.
III- By using Wheatstone Bridge:

Theory:

Ohm’s law method can’t be used to measure low values of resistors, because it causes a high current passes through the resistor from the power supply and these resistors can’t bear a high current. In contrast Wheatstone Bridge method is used to measure high and medium values of resistances.

In Wheatstone Bridge method, the current is divided between the two branches. This is why this method is preferable in measuring low values of resistances.

Wheatstone Bridge:

<table>
<thead>
<tr>
<th>R (KΩ)</th>
<th>R (KΩ) meas.</th>
<th>% Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10K</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Let R4 is unknown resistance. If resistors R1, R2 and R3 are arranged in such away as to produce zero deflection of the voltmeter which is connected
between the points B and A, the voltage droops across R1 and R2 are equal and the voltage drops across R3 and R4 are also equal.

\[ I_1 R_1 = I_2 R_{var} \ldots \ldots \ldots (1) \]
\[ I_3 R_3 = I_4 R_4 \]
\[ But \ I_1 = I_2, \ I_3 = I_4 \]
\[ \Rightarrow I_1 R_3 = I_2 R_4 \ldots \ldots \ldots \ldots (2) \]

Dividing (2) by (1), we get:

\[ \frac{R_4}{R_{var}} = \frac{R_{unk}}{R_{var}} = \frac{R_3}{R_1} \]

\[ \therefore R_{unk} = R_{var} \times \frac{R_3}{R_1} \]

Experimental procedures:

1- Connect the circuit as shown in figure (1.4)
2- Let R1=R3=1 KΩ, R4=10 KΩ (to be proved), R2 variable is of the range 10 KΩ.
3- Vary R2 until V=0, then measure R2 var and use this value to compute Runk. From the relation

\[ R_{unk} = R_{var} \times \frac{R_3}{R_1} \]

4- Compute the percentage of error.
5- Repeat the previous four steps if:
   - R1=1 KΩ, R3=1.8 KΩ, R4(unk)=22 KΩ (to be proved), R2 variable of the range 10 KΩ.
   - R1=1.8 KΩ, R3=1 KΩ, R4(unk)=6.8 KΩ (to be proved), R2 variable of the range 10 KΩ.

<table>
<thead>
<tr>
<th>R1(KΩ)</th>
<th>R3(KΩ)</th>
<th>Runk.(KΩ)</th>
<th>Rvar.(KΩ)</th>
<th>Runk. measured</th>
<th>% Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.8</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>1</td>
<td>6.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table (1.3)
6-

- Repeat steps 1-4 for the figure (1.5).
- Is there any difference between the result of figure (1.4) and figure (1.5)?
- Note:
  - \( x_l = \omega L = 2\pi fL \)
  - \( x_C = \frac{1}{2\pi fC} \)