KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

Electrical Engineering Department

EE 208 ELECTRICAL SYSTEMS

Experiment # 4 EQUIVALENT RESISTANCE: OPEN & SHORT CIRCUITS

OBJECTIVE:

1- To experimentally study the effect of the **open** circuit and **short** circuit as electrical elements.
2- To study how to **measure** the **equivalent** resistance of a circuit experimentally and **compare** it to the **calculated** values.

APPARATUS: DC Power Supply
Ohmmeter, DC Voltmeter and DC Ammeter
Carbon Resistors: 100 Ω, 150 Ω, 220 Ω, 330 Ω, 330 Ω.

THEORY:

The short and the open circuits are the simplest of the electrical systems, yet their **effects** can sometimes be **confusing** and this mishandled by student.

- **The short circuit:**

By definition, a short circuit represents a resistor of zero value, **R = 0**Ω (i.e. no resistance). Thus:

$$V = I\,R = I \times 0 = 0 \qquad (1)$$

Equation (1) states that the **voltage** across a short circuit is **always zero**, regardless of the current through it. Thus:

1- Ohm's law **cannot** be **used** to find the current through a short circuit.
2- If a short circuit is **placed in parallel** to any electrical element, it **forces** the **voltage** across that element to **be zero**, as illustrated in figure 1.

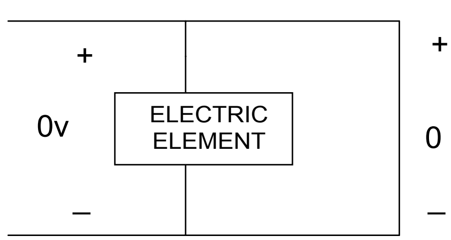
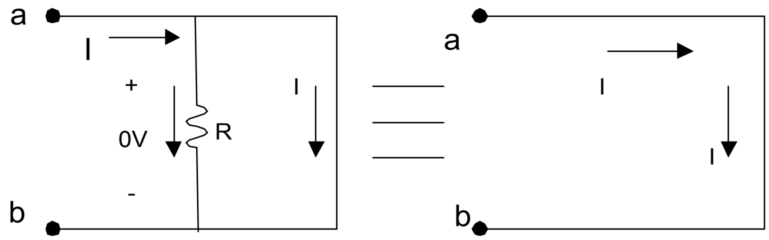


Figure 1

3- If a short circuit is placed in **parallel to a resistor**, the **equivalent** resistance is **zero** (i.e. a short-circuit). The resistor in this case has no effect and can be removed from the circuit. In this case, the **current** entering the parallel combination flows **entirely** in the **short** circuit. This is illustrated in figure 2. If the short circuit is in parallel to an element that is **not a resistor** (such as a current source), the **element should not** be **removed** form the



circuit.

Figure 2

- **The Open Circuit:**

By definition, an **open** circuit represents a resistor of **infinite** value**, R =** $\infty\,\Omega$ (i.e. infinite resistance). Thus:

$$I = \frac{V}{R} = \frac{V}{\infty} = 0 \qquad (2)$$

Equation (2) states that the **current** through an **open** circuit is **always zero**, **regardless** of he **voltage** across it. Thus:

1- Ohm's law **cannot** be **used** to find the voltage across an open circuit.
2- If an open circuit is **placed in series** with any electric element it forces the **current** through that element to be **zero**, as illustrated in Figure 3.

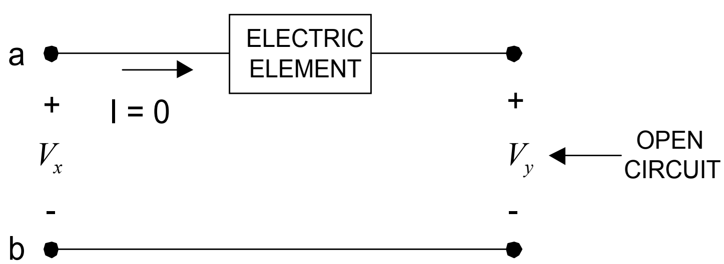


Figure 3

3- If an **open** circuit is **placed** in **series** with a resistor, the equivalent resistance is **infinite or an open circuit**. The resistor in this case has no effect and can be **removed** form the circuit. The **voltage** across the series combination in this case, appears **entirely** across the **open circuit**. This is illustrated in figure 4. If the open circuit is in series to an element, which is **not a resistor** the element **should not** be **removed** from the circuit.

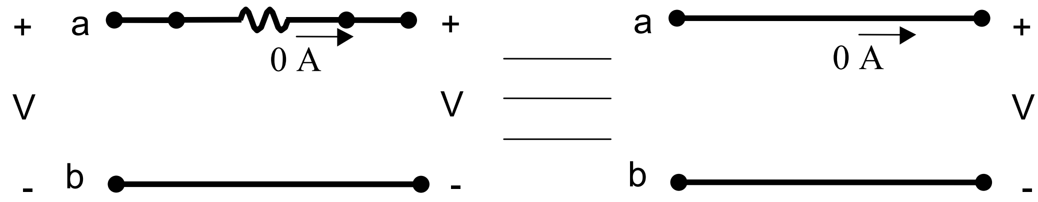


Figure 4

PROCEDURE:

1- **Check** the value of the resistor used in the circuit of **Figure 5**, using the Ohmmeter. Record the values in table 1.

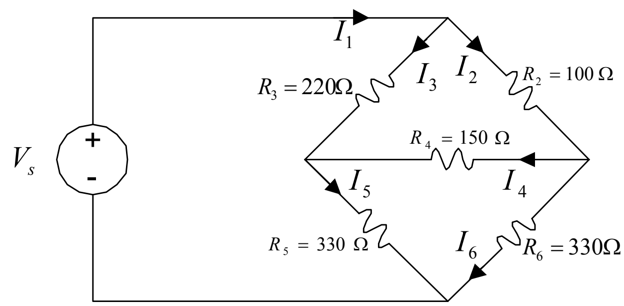


Figure 5

2- **Connect** the circuit of Figure 5 and adjust the supply voltage **V_s to the 10 V**, using a DC voltmeter.

3- **Measure I_1**. **Find R_{eq}** using the V_s/I_1. Record its value in Table 2.

4- **Disconnect** the voltage source and **measure Req** using an Ohmmeter for the cases (A) through (M) listed below. Record the values in Table 2.

A. Measure **Req** between the **two terminals** that were connected to the **voltage** source.

B. Replace only **R_2** by a **short** circuit then **measure Req** between the same terminals.

C. Repeat step 2 if only **R_4** is replaced by a **short** circuit.

D. Repeat step 2 if only **R_2** and **R_5** are replaced by a **short** circuit.

E. Repeat step 2 if only **R_2** and **R_4** are replaced by a **short** circuit

F. Repeat step 2 if only **R_2** and **R_3** are replaced by a **short** circuit

G. Repeat step 2 if only **R_2** is replaced by an **open** circuit.

H. Repeat step 2 if only **R_4** is replaced by an **open** circuit.

I. Repeat step 2 if only **R_2** and **R_5** are replaced by an **open** circuit.

J. Repeat step 2 if only **R_2** and **R_4** are replaced by an **open** circuit.

K. Repeat step 2 if only **R_2** and **R_3** are replaced by an **open** circuit.

L. Repeat step 2 if only **R_2** is a **short** circuit and **R_5** is an **open** circuit

M. Repeat step 2 if only **R_2** is an **open** circuit and **R_4** is a **short** circuit.

REPORT:

1- **Calculate the theoretical** values of $\mathbf{R_{eq}}$ for cases (A) through (M) listed in the procedure above. Record the results in Table 2.

2- **Compare** the **theoretical** and **experimental** values of R_{eq} for cases (A) through (M) listed in the procedure above by calculating the % difference and record your calculation in Table 2.

3- **Give reasons** for any discrepancies between the theoretical and experimental values.

EXPERIMENT # 4 Laboratory Report

Name: .... **I.D.** .... **Lab. Section:** ....

TABLE 1

Resistor Values:

Resistor	R_2	R_3	R_4	R_5	R_6
Nominal Value (Ω)	100	220	150	330	330
Ohmmeter reading					

TABLE 2

$\mathbf{R_{eq}}$:

Case	A	B	C	D	E	F	G	H	I	J	K	L	M
Theoretical (Ω)													
Experimental (Ω)													
% Error													