UNIVERSITY OF WOLLONGONG IN DUBAI
Faculty of Engineering and Information Sciences

Lab Experiment: Internal resistance – Electrical meters

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Family Name:	________	________	________	________
First Name:	________	________	________	________
Student Number:	________	________	________	________

Objectives:

Part 1: Measurement of internal resistance of a meter
Part 2: Measurement of an unknown resistor using the Wheatstone bridge method
Part 3: Calculate the resistivity ρ of a wire

Part 1: Meter Internal Resistance Measurement

Equipment:

- Power supply
- One resistor of a value 100k Ohms
- Resistance box
- Ammeter
- 4 banana cables

Measurement of the internal resistance of the meter is accomplished by connecting the meter to a current source. A current source may be approximated by a voltage source connected in series to a high resistance. The current source is adjusted to produce a full-scale reading on the meter being measured. Then, a resistance decade box is connected in parallel with the meter, and the resistance is adjusted to produce exactly a half-scale reading on the meter. Now, only half of the original current flows through the meter; the other half of flows through the resistance decade box. Since the decade box and the meter are connected in parallel, the same voltage appears across each. Therefore, since the current flowing through each is also the same, the resistance of the meter movement must be equal to the resistance setting of the decade box.

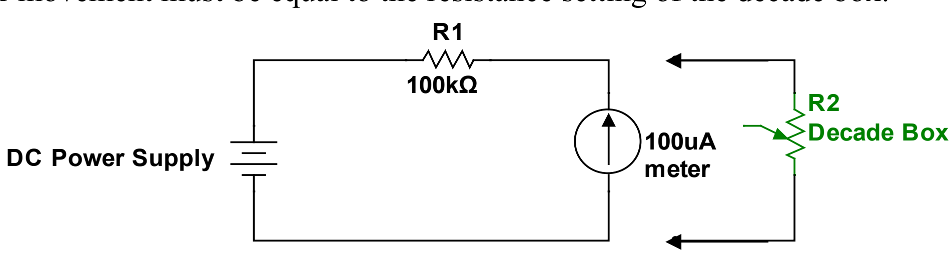

Figure 1

1. Connect the circuit shown in Figure 1, but leave the power supply turned off.
2. Make sure that the meter indicator mechanical zero is set properly so that the indicator reads precisely zero with no current passing through the meter.
3. After the lab instructor inspects your circuit. Turn on the power supply and adjust the output voltage to produce exactly full-scale deflection on the meter being measured.
4. Connect the resistance decade box in parallel with the meter.
5. Set all of the decade box switches to the OFF position.
6. Add resistance on the decade box to produce exactly a half-scale deflection on the meter.
7. The decade box resistance is the sum of all the switch settings that are in the ON position. This value is also internal resistance of the meter. Record this resistance.
8. Turn off the voltage source.

Part 2: Wheatstone Bridge

Equipment:

- Power supply
- 2 resistors
- Slide wire
- Galvanometer, Voltmeter, or Ammeter
- 6 banana cables

Theory

A Wheatstone bridge is show in Figure 2. There are four resistors. Using this method, one can determine the resistance of the unknown resistor if the other three are known.

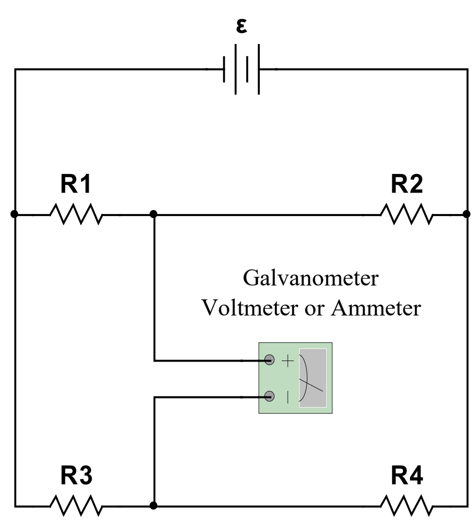

Figure 2: DC Wheatstone bridge.

When the bridge is balanced, the current flow (or the voltage drop) through the galvanometer becomes zero. Hance the current flows through R_1 and R_2 are the same and the current flows through R_3 and R_4 are the same:

$$I_1 = I_2 \tag{1.a}$$

and

$$I_3 = I_4 \tag{1.b}$$

On the other hand, the voltage drops on R_1 and R_3 become the same and the voltage drops on R_2 and R_4 become the same:

$$V_1 = V_3 \tag{2.a}$$

and

$$V_2 = V_4 \tag{2.b}$$

If Eqs. (1) and (2) are rearranged, the final relation is obtained:

$$\frac{R_1}{R_2} = \frac{R_3}{R_4} \tag{3}$$

Experimental Procedure

1. Connect the circuit as shown in Figure 3 using a slide wire.

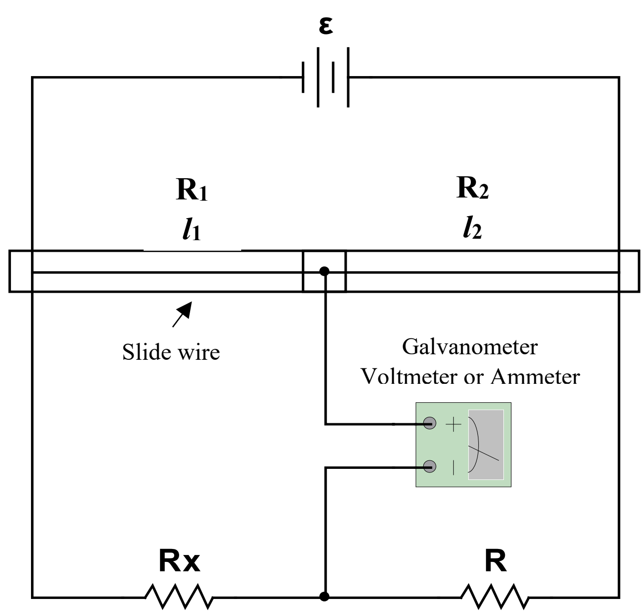

Figure 3: Set-up for DC Wheatstone bridge measurements.

2. Using a known (R) and unknown resistor (R_x), balance the bridge by moving the slider. The current flow (or the voltage drop) through the galvanometer must be zero.

3. Measure the l_1 and l_2 lengths and record them on the table 1. The resistance of R_1 and R_2 are proportional to their lengths:

$$\frac{R_1}{R_2} = \frac{\rho\frac{l_1}{A}}{\rho\frac{l_2}{A}} = \frac{l_1}{l_2} \tag{4}$$

where ρ and A, the resistivity and the cross-sectional area respectively are the same for the slide wire.

4. Calculate the resistance of the unknown resistor using Eqs. (3) and (4). Record it on the table 1.

5. Calculate the percentage error and record it on table 1.

6. Repeat all procedure for one more unknown resistor.

Table 1: DC Wheatstone bridge calculations

R (Ω)	l_1 (cm)	l_2 (cm)	R_x (Ω)	$R_{x,\text{ theory}}$ (Ω)	Percent error

Part 3: Resistivity of a Wire

Resistance Apparatus 1009949

Instruction sheet

10/15 ADP BJK

1 4-mm connectors
2 Base plate
3 Resistance wires

1. Safety instructions

If the current is too high, it can lead to the resistance wires becoming destroyed.

- Do not exceed the stated values for current.

The resistance wires are thin and can stretch or snap.

- Always carry the device by the base plate, never try to lift the wires.

2. Description

The resistance measurement bridge is a useful tool for exploring the factors that contribute to a wire's overall resistance. It is used to investigate the dependency of electrical resistance on conductor length, conductor cross-section and material.

The resistance measurement bridge is made up of six wires laid out side by side on a base plate with both ends connected to 4-mm sockets.

3. Technical data

Material	Diameter	Current
Constantan	1 mm	2 A max.
Constantan 2x	0.7 mm	2 A max.
Constantan	0.5 mm	1.5 A max.
Constantan	0.35 mm	1 A max.
Brass	0.5 mm	2.5 A max.

Dimensions: 1085 x 70 x 55 mm^3
Length of wires: 1000 mm
Weight: approx. 1.5 kg

4. Sample experiments

It is recommended to use the analogue multimeter AM51 (1003074) to determine the resistance of the wires.

To avoid measuring errors, it is necessary to take account of the resistance of cables.

- The multimeter leads should be shorted together so that only their resistance is measured and the meter should then be calibrated to register that resistance as zero.

4.2 Calculating the resistivity ρ of a wire

The equation for resistance R of a wire is given by

$$R = \rho \cdot \frac{L}{A}$$

with L = length of the wire, A = cross sectional area of the wire and ρ = resistivity of the material

Solving our equation of resistance for ρ, we get:

$$\rho = R \cdot \frac{A}{L}$$

- Set up the experiment according to fig. 1.
- Connect the LCR to any of the constantan wires and determine its resistance.
- Calculate the resistivity of Constantan.
- Repeat the experiment with the brass wire and compare the resistivity of Constantan and Brass.

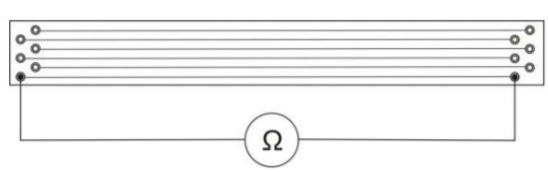

Fig. 1 Experimental set-up