Kuwait University Physics department

Pre-laboratory session

Laboratory course 107

Objectives:

- To learn the difference between direct current (**dc**) and alternating current (**ac**).
- To introduce the symbols used for electronic components.
- To study the resistors color-coding system.
- To get familiar with the experimenter design (Heathkit).
- To learn how to use the multimeter for voltage, current, and resistance measurements.

Direct and alternating currents:

Direct currents refer to currents, which does not change direction with time. A Battery is one sort of a **dc** current source. Graphically, the relation between a constant **dc** current versus time represents a horizontal straight line as shown in **Figure 1**.

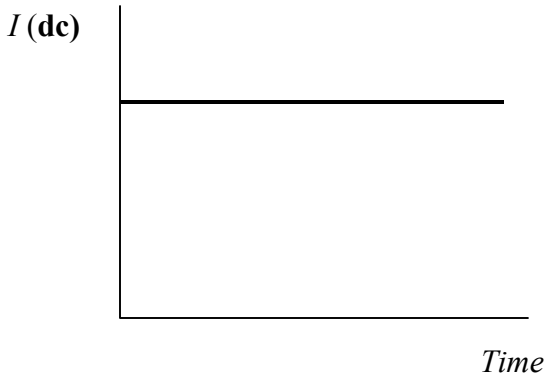
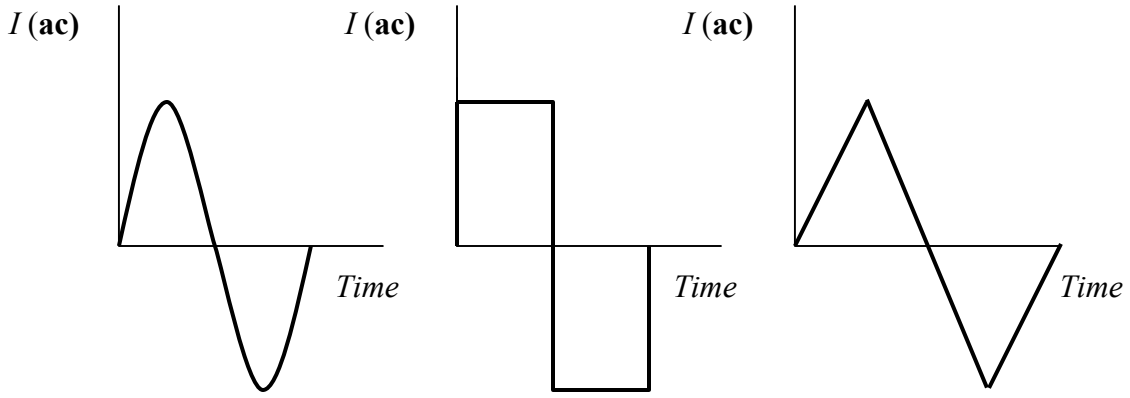


Figure 1

Alternating currents, on other hand, refer to currents, which change direction with time (oscillate). There are different types of **ac** currents: sinusoidal, square, triangular and others (see **Figure 2**).



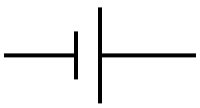
(a) sinusoidal (b) square (c) triangular

Figure 2

The sinusoidal current is the most popular one among the others, since it is the natural output of the commercial alternating current generators or *alternators*. The other types of **ac** currents are actually produced from the sinusoidal one, using some special electronic devices.

Symbols used for electronic components:

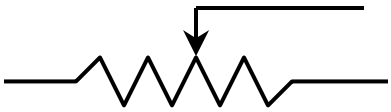
Listed below, are symbols used for electronic components used in the experiments, which are introduced in this course:



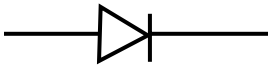
dc power source

ac power source

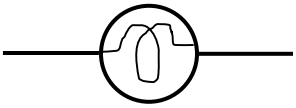
Resistor



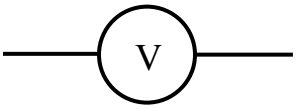
Variable resistor (potentiometer)



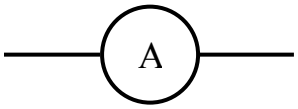
Diode



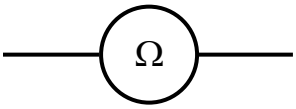
Filament



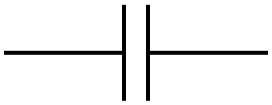
Voltmeter



Ameter



Ohmeter



Capacitor

Resistors color-coding system:

Resistors forms the most basic and popular electric components used in electric circuitry. Since the size of resistors is fairly small, color-coding system is adapted for the value of a resistor. So rather than writing the value of the resistor on its body, parallel color bands are drawn, representing the value of the resistor.

Colors are given numbers from 0 – 9 according to the following list:

Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

The coding system is best illustrated using an example:

Example 1: Consider the resistor shown in Figure 3. Let x, y, and z represents the numbers of the three colors (scanned from left to right) as given in the list, then the value of the resister

$$R = xy \times 10^z$$

x y z Gold or Silver

Figure 3

That is, the numbers of the first two colors are written adjacently to form a 2-digit number multiplied by the number 10 raised to a power z.

The fourth color, which can be gold or silver, represents the tolerance (accuracy) in the value of the resistor. So if it is gold, then the tolerance is 5%, whereas if it is silver, then the tolerance is 10%.

Example 2: Let the colors of a given resistor be: brown, black, red, and the fourth color be gold. Determine the value of the resistor and the tolerance.

Solution: The numbers of the four colors as from the color-coding list (successively) are: 1, 0, 2, and 5. Therefore the resistance

$R = 10 \times 10^2 = 1000\ \Omega$.

And the tolerance = 5% × 1000 = 50 Ω, i.e.: the actual value of the resistor ranges from 950 Ω -1000 Ω.

The electronic design experimenter (Heathkit):

The electronic design experimenter is a device used for designing some basic electronic circuits. It consists mainly of 7 units as shown in **Figure 4**:

1. **POWER** switch**:** Turns the trainer on and off.
2. **POWER SUPLLY:** consists of positive control (range: 1 V-15 V), which adjusts the output of the positive power supply, and negative control (range: -1 V – (-15) V), which adjusts the output of the negative power supply, and three connectors: POS, GND, and NEG which stands for positive, ground, and negative.
3. **LINE FREQUENCY:** consists of three connectors and supplies a 50 Hz 15 V **ac** power.
4. **GENERATOR:** Supplies a variable frequency (range: 0 Hz – 2 kHz, and can be upgraded to 20 kHz by setting the range switch to 10X) **ac** power.
5. **1 kΩ** variable resistor: consists of a control along with three connectors.
6. **100 kΩ** variable resistor: consists of a control along with three connectors.
7. **BREADBORD:** consists of 4 units: two lines (one at the top and the other at the bottom), of 50 (internally connected) connectors, besides two blocks each consists of a group of a vertical 5 (internally connected) connectors.

How to use the multimeter for voltage, current, and resistance measurements:

Voltage measurement:

To measure the voltage across any electrical component in a circuit, a resistor for example, do following steps:

a) Set the dial of the multimeter to the voltage position ($\overline{V}$ for **dc** or $\tilde{V}$ for **ac**).
b) Let the black probe (terminal) of the multimeter be plugged into the COM socket, and the red probe plugged into the V socket.
c) Connect the two probes of the multimeter in parallel to the resistor, as shown in **Figure 5.**

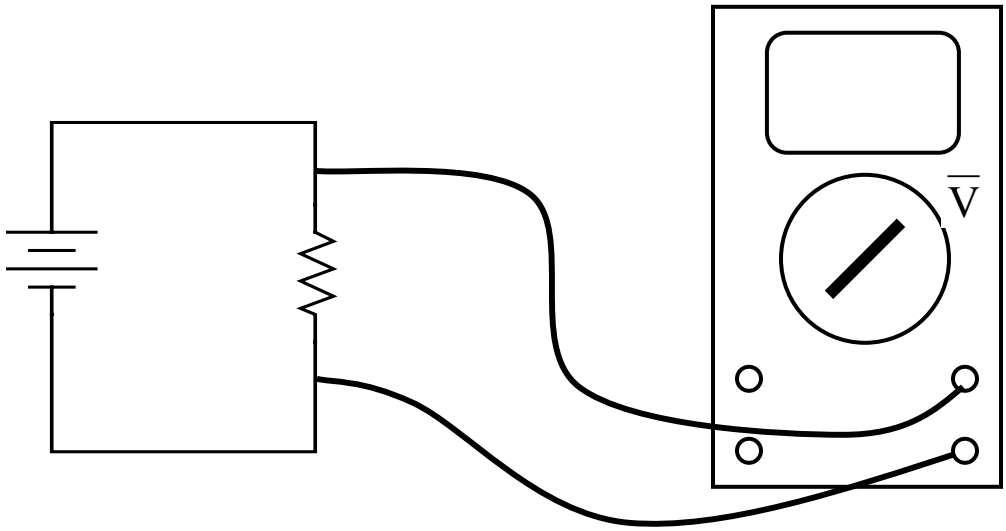


Figure 5

current measurement:

To measure the current through any electrical component in a circuit, a resistor for example, do following steps:

a) Set the dial of the multimeter to the current position ($\overline{\text{A}}$ for **dc** or $\tilde{\text{A}}$ for **ac**).
b) Let the black probe of the multimeter be plugged into the COM socket, and the red probe be plugged into the A socket.
c) Connect the two probes of the multimeter in series to the resistor, as shown in **Fig. 6.**

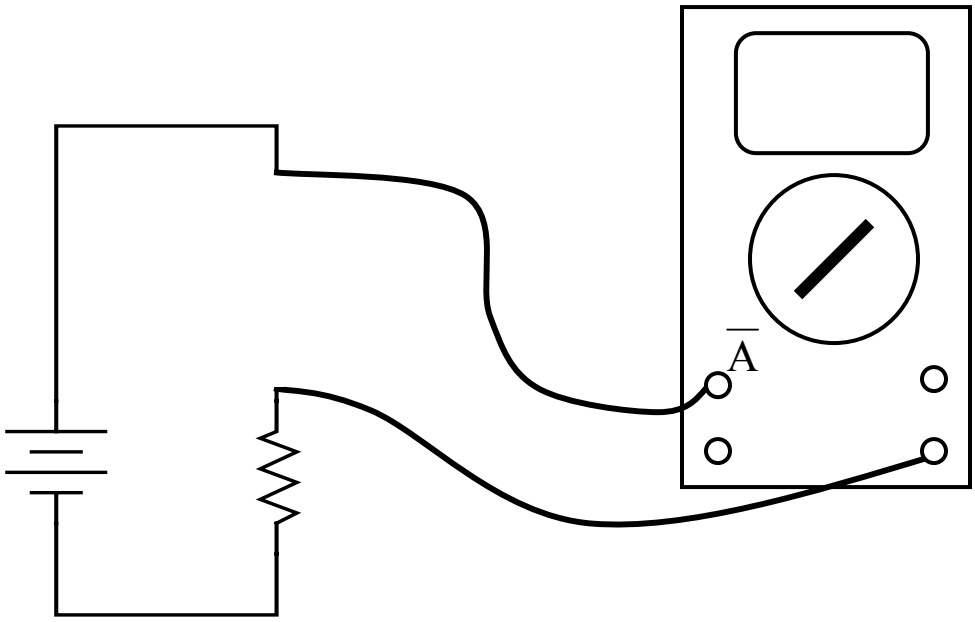


Figure 6

resistance measurement:

To measure the resistance of any electrical component in a circuit, a resistor for example, do following steps:

a) Disconnect the resistor from the circuit.
b) Set the dial of the multimeter to the Ohm position (Ω).
c) Let the black probe of the multimeter be plugged into the COM socket, and the red probe is plugged into the Ω socket.
d) Connect the two probes of the multimeter in parallel to the resistor, as shown in **Figure 7.**

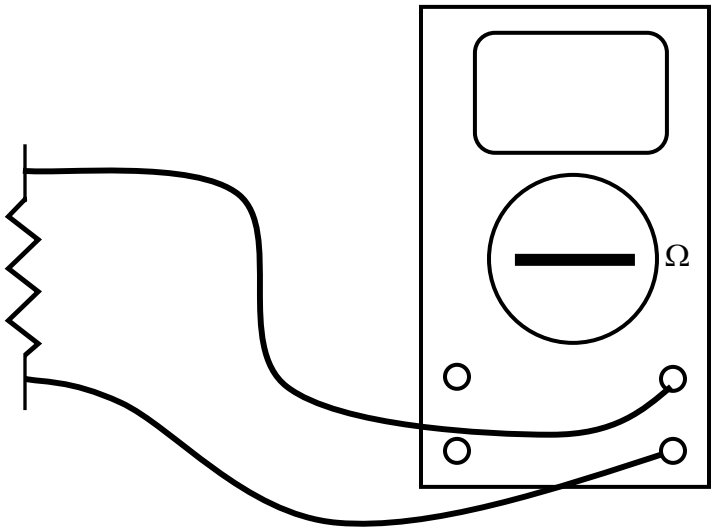


Figure 7

Equipment:

Electronic design experimenter (Heathkit)

100 Ω, 220 Ω, 390 Ω, 560 Ω, and 1 kΩ resistors.

Multimeter

Procedure:

1- Measure the resistance values for the given resistors and record in **Table I.**

2- Connect the single loop circuit as shown in **Figure 8**, using the 100 Ω resistor.

3- Set the voltage of the **dc** power supply to 5 V.

4- Measure the voltage across the resistor. Record in the Table.

5- Measure the current through the resistor. Record in the Table.

6- Repeat steps 2-5 for the other resistors.

7- Compare your measure values for the currents to the estimated values, if your values are within 5% of the estimated values, then you are doing fine!.

Table I (power supply value = 5 V)

No.	R_{coded} Ω	$R_{measured}$ Ω	V (V)	I (mA)	$I_{estimated}$ (mA)
1	**100**				**50**
2	**220**				**22.7**
3	**390**				**12.8**
4	**560**				**8.9**
5	**1000**				**5**

Conclusion