

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**.

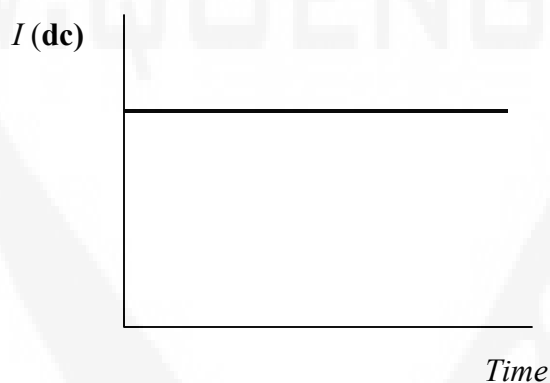


Figure 1

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**).

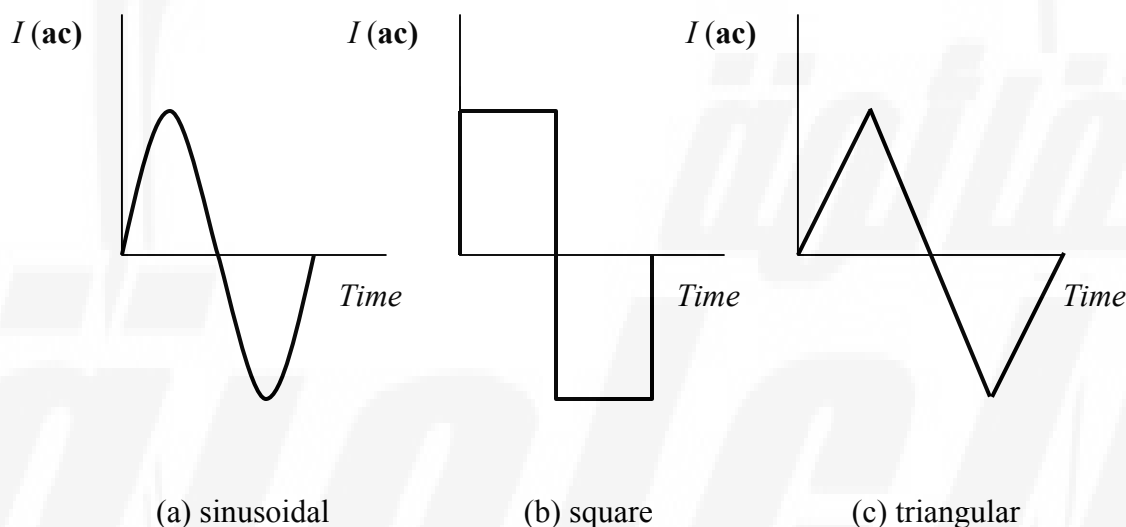
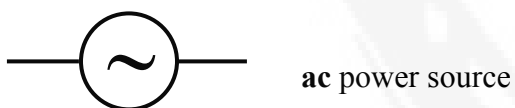


Figure 2

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.

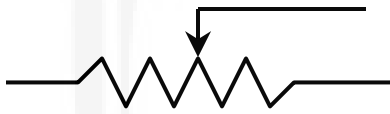
Symbols used for electronic components:

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





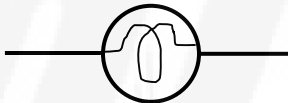
Resistor



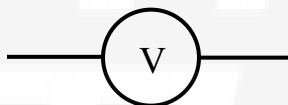
Variable resistor (potentiometer)



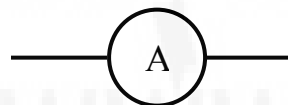
Diode



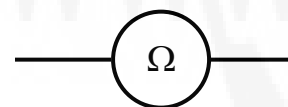
Filament



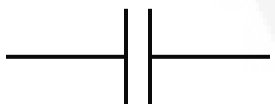
Voltmeter



Ammeter



Ohmmeter



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 resistor

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

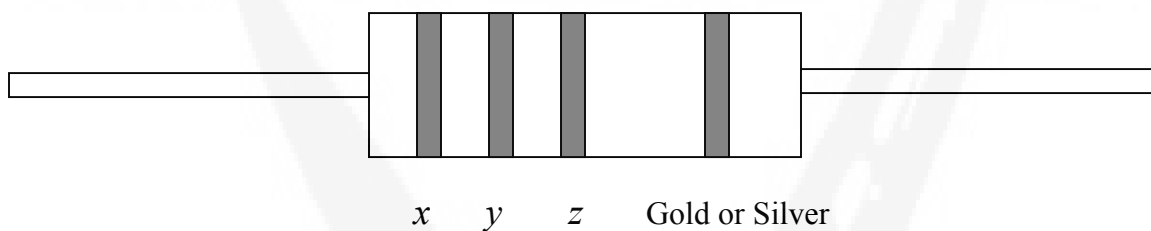


Figure 3

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 = $5\% \times 1000 = 50 \Omega$, i.e.: the actual value of the resistor ranges from 950Ω - 1000Ω .

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 SUPPLY:** 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 k Ω** variable resistor: consists of a control along with three connectors.
6. **100 k Ω** variable resistor: consists of a control along with three connectors.
7. **BREADBOARD:** 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:

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

Figure 5.

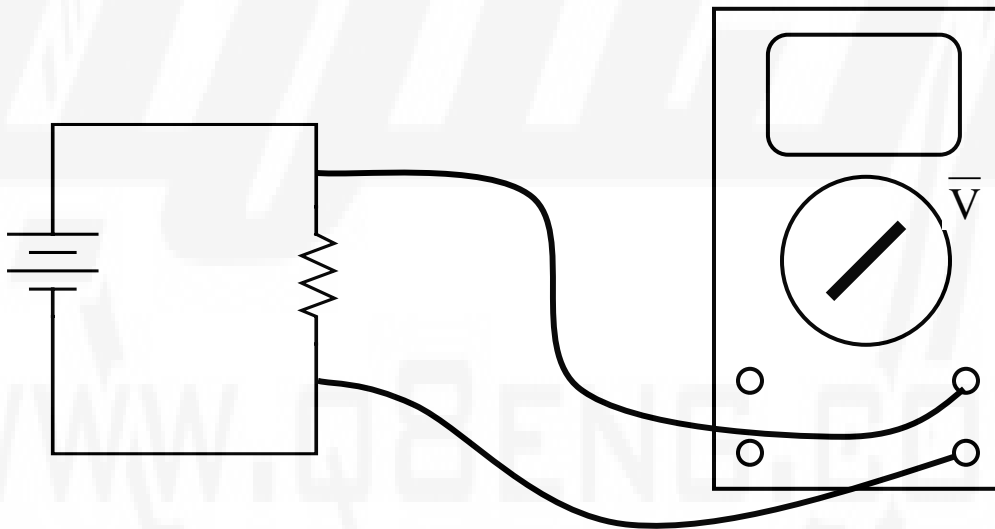


Figure 5

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 (\bar{A} for **dc** or \tilde{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**.

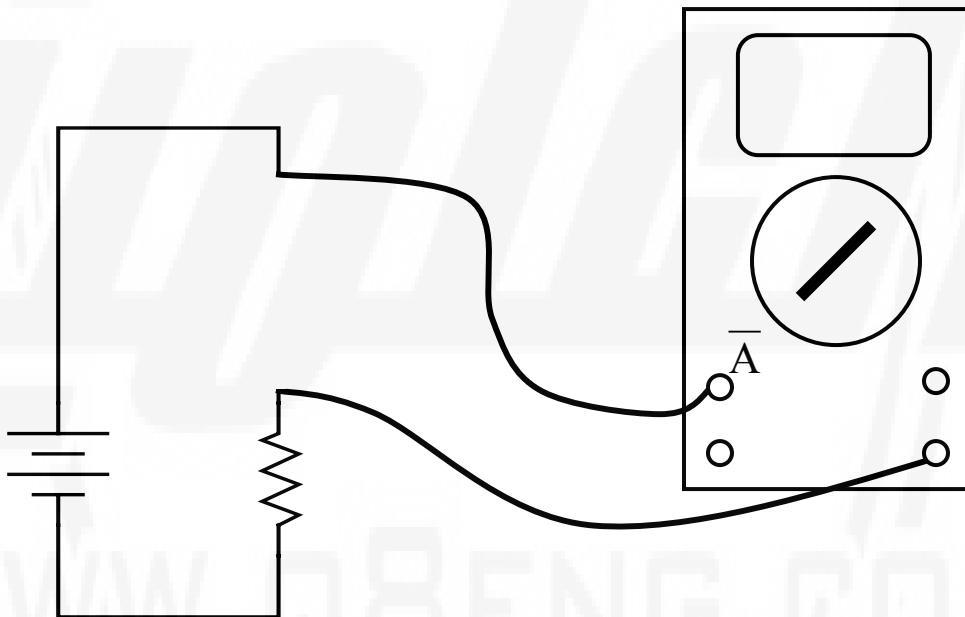


Figure 6

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.

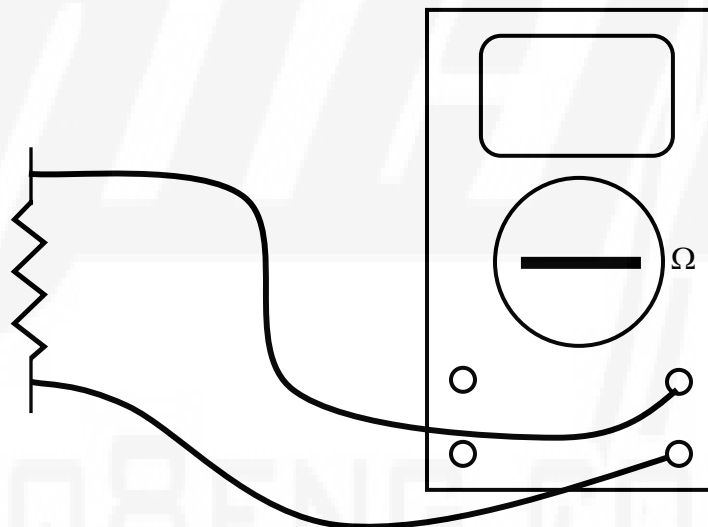


Figure 7

Equipment:

Electronic design experimenter (Heathkit)

100 Ω , 220 Ω , 390 Ω , 560 Ω , and 1 k Ω 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