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كلية التكنولوجيا
Faculty of Technology
قسم الهندسة الكهربائية و قسم الإلكترونيك
Department of Electrical Engineering and Department of Electronics
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University year: 2024/2025 — السنة الجامعية: 2024 /2025
2nd year Electrical Engineering and Electronics — السنة الثانية هندسة كهربائية و إلكترونيك
Applied Work in Fundamentals of Electronics 1 — أعمال تطبيقية في الالكرونيك الأساسية 1

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PW n°01 : Introduction to Equipment and Essential Reminders

Duration : $1^{h}30$.

Date of the experiment: ………. /……../………….. .

Report prepared by:

Last Name	**First Name**	**Group**	**S/Group**	**Final Note**
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-	-	-	-	-
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Instructions :

- **Internal laboratory regulations must be observed.**
- **You must wear a lab coat.**
- **Attendance is compulsory and will be monitored. Any unjustified absence or failure to hand in a report will result in a mark of 0/20.**
- **Have your assemblies checked before connecting the voltage source.**
- **It is strictly forbidden to move equipment from one station to another. In the event of a breakdown or faulty equipment, contact the teacher.**
- **The report must be written by a maximum of four students.**
- **The report must be handed in at the beginning of the next session.**
- **The report must include the following sections:**
  - **TP cover page.**
  - **The date of the practical session.**
  - **Last Name and first name of the main writer.**
  - **Last Names and first names of the WP participants.**
  - **Preparation and work in manuscript.**

Person in charge of practical work: Dr ROUABHI.R

***PW n°01*: Introduction to Equipment and Essential Reminders**

1. Purpose of the Experiment

The primary objective of this laboratory exercise is to familiarize students with electrical components, including resistors, measuring instruments, and the wiring of direct current (DC) electrical circuits. We will specifically examine the laws relating charge and potential difference for resistors, as well as practical applications of these laws in measuring electric current.

2. Theoretical Overview

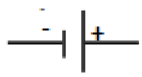
2.1. Measuring and Testing Instruments

A measuring instrument (or measuring device) is a tool designed to experimentally obtain values that can be attributed to a specific physical quantity. The device used to measure the potential difference between two points in a circuit is called a voltmeter. An ammeter is employed to measure the current in a branch of the circuit, while an ohmmeter is used to measure the resistance of a portion of the circuit. Additionally, potential differences can be analyzed using an oscilloscope, which we will discuss later. Each measuring instrument features two probes—wires extending from the device that must be connected to the circuit appropriately to obtain accurate measurements. The measuring equipment available in the measurement laboratory at the Faculty of Technology, University of M'sila, is detailed in the attached appendix.

- Digital DC Power Supply with Analog and Digital Display
- Analog Voltmeter
-Analog Ammeter
- Digital Multimeter
- Oscilloscope
- Function Generator (Low-Frequency Generator, GBF)
- Test Bench
- Cables and Probes

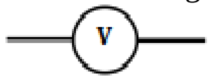
2.1.1. DC Power Supply

A direct current (DC) power supply is a device capable of providing or dissipating electrical energy. Educational power supplies are specifically designed for laboratory use. These power supplies feature fixed or adjustable current or voltage outputs, allowing users to limit the current or voltage to a predetermined level. This capability helps prevent circuit interruption during testing (see Appendix A).

The symbol used to represent a DC power supply in an electrical circuit diagram is as follows: 

2.1.2. The Voltmeter

A voltmeter is an instrument used to measure the potential difference between two points in an electrical circuit. The symbol used to represent a voltmeter in an electrical circuit diagram is as follows:



The voltmeter (see Appendix D) measures the potential difference between two arbitrary points, a andb, in a circuit (Figure 1). Therefore, one probe must be connected to each of these points, and the voltmeter is placed in parallel with the branch or branches of the circuit located between points a and b.

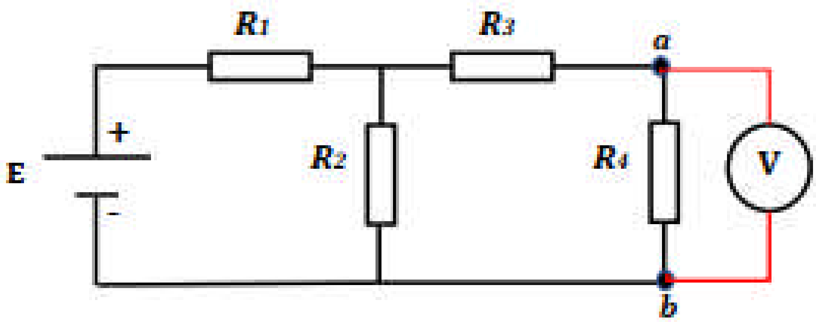


Figure 1: Voltage Measurement Using a Voltmeter

2.1.3. The Ammeter

An ammeter is an instrument used to measure the electric current flowing through a circuit. The symbol used to represent an ammeter in an electrical circuit diagram is as follows: 

The ammeter (see Appendix D) measures the current flowing through a branch of the circuit, and it must be connected in series with that branch to ensure that the same current flowing through the branch also passes through the ammeter. To measure the current, the branch must first be disconnected to insert the ammeter into the circuit. In Figure 2, the ammeter is connected in series with resistor R4 and as a result, measures the current flowing through R4

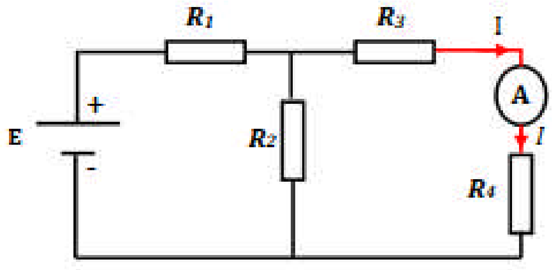
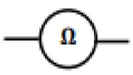


Figure 2: Current Measurement with Ammeter.

2.1.4. The Ohmmeter

The symbol used to represent an ohmmeter in a circuit is as follows: 

Unlike voltmeters and ammeters, the ohmmeter is an active device; it contains an internal battery of known value that supplies current to the circuit being measured. To measure the value of a resistor or a combination of resistors, both probes of the ohmmeter must be connected to the terminals of the resistor or resistive combination, ensuring that it is not receiving current from the rest of the circuit. If the circuit were still connected, the current from the circuit would combine with the current supplied by the ohmmeter, leading to an inaccurate measurement.

Figure 3(a) illustrates a correct method for measuring the resistance R4 in the circuit shown in Figure 2. Note that only one of the connections between R4 and the rest of the circuit has been broken. While it is possible to disconnect both connections, it is not necessary; interrupting the branch at any point is sufficient to prevent current from flowing through R4.

Figure 3(b) shows a correct method for measuring the combined resistance of resistors R3 and R4 connected in parallel.

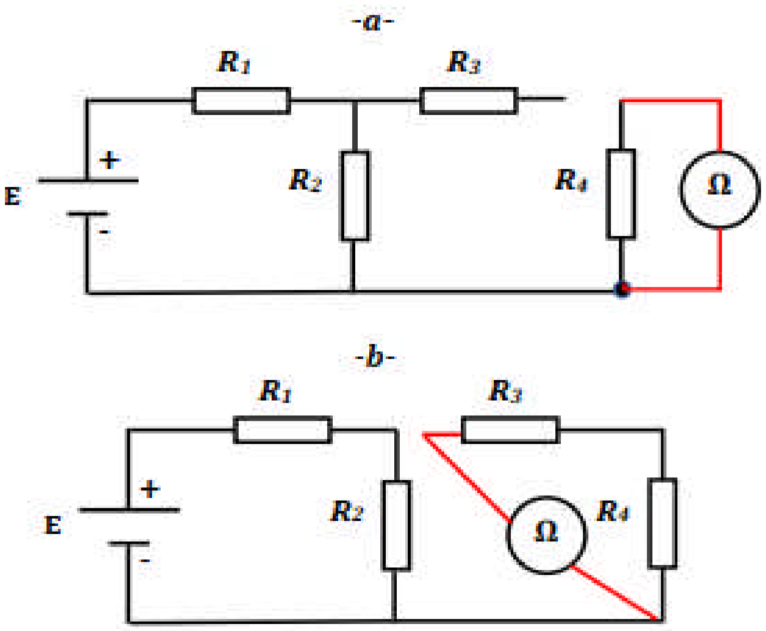


Figure 3: Resistance Measurement in an Electrical Circuit

2.1.5. The Multimeter

In practice, the various instruments described above are often combined into a single device known as a multimeter (see Appendix C). This device can be configured to function as a voltmeter, ammeter, or ohmmeter, and it allows the selection of different sensitivity ranges. Analog measuring devices are typically constructed from a galvanometer, which operates based on magnetic effects. However, these analog devices have largely been replaced by digital displays that are generally less expensive, more robust, and more precise. Digital multimeters do not rely on galvanometers; instead, they use electronic circuits with transistors to facilitate direct measurement of potential difference.

Note: *For alternating currents, multimeters display effective values for both current and voltage, not peak or maximum values.*

2.1.6. The Oscilloscope

While it can measure a continuous potential difference, the oscilloscope is particularly well-suited for studying alternating voltages. It allows not only the measurement of amplitude but also the observation of the waveform over time (see Appendix B). The oscilloscope consists of a cathode ray tube (CRT) housed in a glass envelope containing a vacuum (see Figure 4). Electrons are emitted from a heated cathode and accelerated by a high voltage applied to the anode, which has a small aperture. The electron beam is directed onto a fluorescent screen, where it creates a visible trace or spot.

Before reaching the screen, the electron beam passes between two pairs of plates to which a potential difference can be applied, creating an electric field between them. Consequently, a force acts on the electrons. One pair of plates is oriented vertically and deflects the beam horizontally, while the other pair is horizontal and deflects the beam vertically. By varying the voltages on the plates, the spot created by the electrons on the screen moves, tracing a path that can be observed.

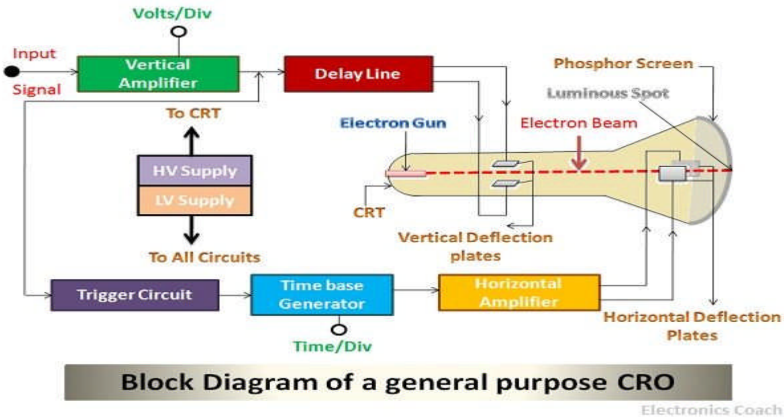


Figure. 4 : Schéma synoptique d'un oscilloscope.

The most common mode of operation for the oscilloscope involves applying a sweep voltage to the vertical plates. This causes the spot to deflect from left to right at a constant speed, returning quickly to the left when it reaches the right edge of the screen. The potential difference to be observed is applied between the horizontal plates, resulting in vertical deflection of the spot. The combination of these two deflections allows for the observation of voltage variation over time on the screen.

2.1.7. The Function Generator

A function generator, also known as a low-frequency generator (GBF), is a device used in electronics for testing or troubleshooting electronic circuits. A GBF can produce signals at desired frequencies in the form of sine waves, square waves, or triangular waves. These signals can be observed using an oscilloscope through a simple electrical setup.

2.1.8. The Breadboard

Before soldering a circuit, it is advisable to verify that it functions correctly. A breadboard is an excellent tool for testing a circuit without the need for soldering, allowing for quick checks to ensure there are no errors in the assembly. A breadboard consists of an insulating plastic board dotted with numerous holes. These holes are spaced 2.54 mm apart, which the standard is spacing for electronic components used in our assemblies. Using a breadboard is straightforward once one understands how the holes are interconnected (see Figure 5).

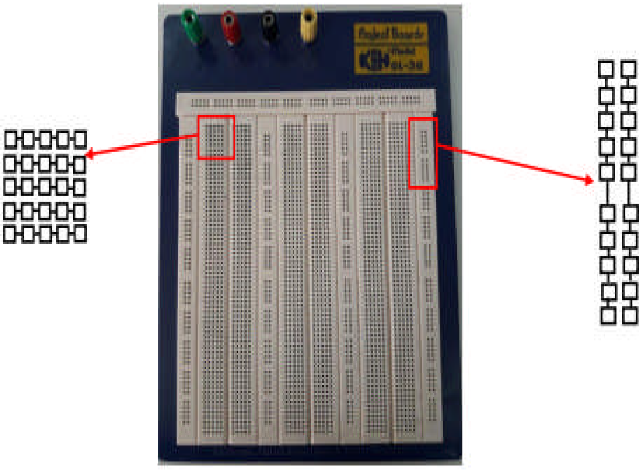


Figure 5: Breadboard

2.2. Introduction to Resistance

A resistor is an electronic or electrical component whose primary characteristic is to oppose the flow of electric current, measured in ohms. Electrical resistance is one of the fundamental components in the field of electricity. The term "resistance" primarily refers to a physical property, but it has also come to denote a specific type of component. Some prefer to call it a "resistive device."

2.2.1. Identification

To determine the ohmic value of a resistor, one must identify the color bands present on the resistor (see Figure 6) and associate them with the universal color code. The international standard IEC

60757, titled "Color Code Designation" (1983), defines a color code that is applied to resistors, indicating their resistance values.

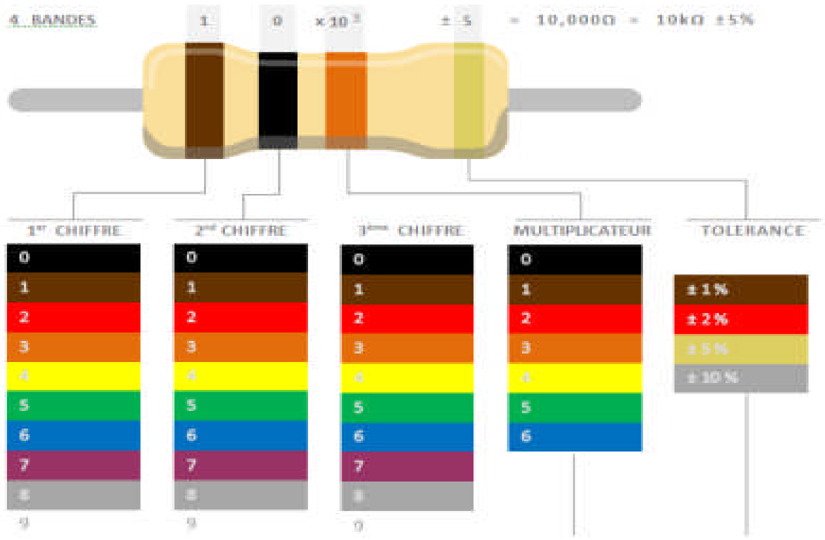


Figure 6: Resistor Color Code

2.2.2. Series Connection of Resistors

When two or more resistors are connected in such a way that the same current flows through each of them successively, they are said to be connected in series. A defining characteristic of series connections is that the current passing through each resistor is identical; thus, all resistors in a series connection carry the same current.

Example: The equivalent resistance R of two resistors connected in series (see Figure 7) can be easily calculated. In this case, both resistors experience the same current of intensity I.

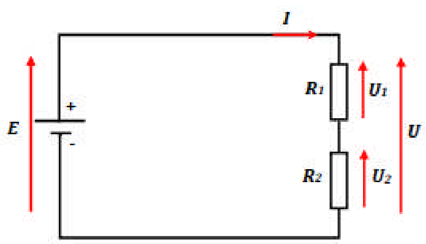


Figure 7: Resistors in Series

Using Ohm's Law, we can express: $U1=R1*I$ $U2=R2*I$

The voltage U across the terminals of the two resistors R1 and R2 which are connected in series, is equal to the sum of the voltages across each resistor: U=U1+U2 =R1*I+R2*I= (R1+R2)*I, where R1+R2=R

The resistance R represents the equivalent resistance of the two resistors R1 and R2 connected in series. Consequently, for N resistors arranged in series, the equivalent resistance can be expressed as: **R=R1+R2+R3+R4+…….RN**

2.2.3. Parallel Connection of Resistors

In this type of configuration (see Figure 8), each of the two resistors R1 and R2 has one terminal connected to the positive (+) terminal of the power supply and the other terminal connected to the negative (-) terminal. As a result, both resistors experience the same voltage provided by the power supply. This condition is a defining characteristic of parallel connections, where the voltage across multiple components connected in parallel is always the same.

Example: Let us calculate the equivalent resistance R of the two resistors connected in parallel, as shown in figure 8.

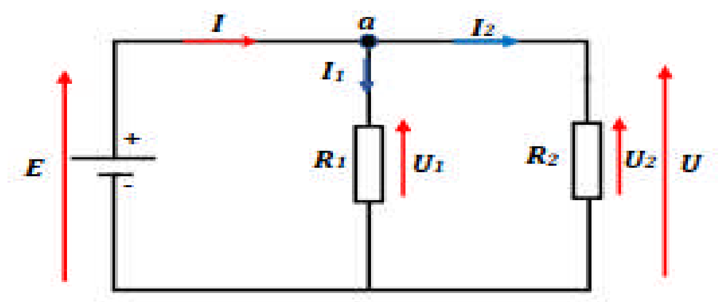


Figure 8: Resistors in Parallel

The two resistors R1 and R2 are subjected to the same voltage: U=U1+U2

The sum of the currents entering a junction is equal to the sum of the currents leaving that junction (known as Kirchhoff's Current Law). In junction of Figure 8, we have: I=I1+I2

By applying Ohm's Law to each of the resistors, we find:

U1=R1*I1 and U2=R2*I2; I1=U1/R1 and I2=U2/R2

We have: I=I1+I2= U/R1+U/R2= U(1/R1+1/R2)

We can deduce the equivalent conductance, denoted as 1/R, as follows: $\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2}$

Consequently, for N resistors connected in parallel, the equivalent resistance can be expressed as:

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \cdots \ldots \ldots + \frac{1}{RN}$$

3. Experimentation

3.1. Personal Work

1. Consider the following electrical circuit:

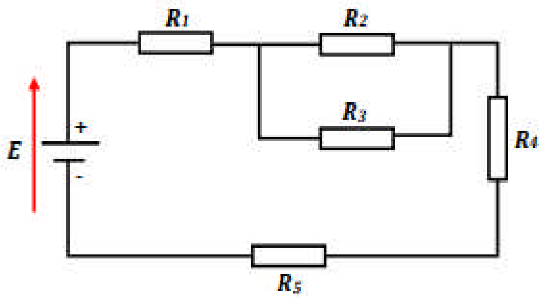


Figure 9

a. Redraw this circuit by including an ammeter to measure the current flowing through the resistor R3

b. Redraw the initial circuit by including a voltmeter to measure the voltage drop across resistors R4 andR5

c. Redraw the initial circuit by including an ohmmeter to measure the resistance R2

2. Consider the following circuit:

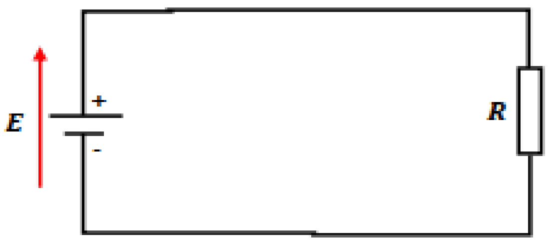


Figure 10

We aim to simultaneously measure the current flowing through resistor R using an ammeter and the voltage difference across R with a voltmeter.

Create a schematic diagram of the setup to be implemented.

The figure below illustrates the screen of an oscilloscope operating in sweep mode, displaying the variation of a sinusoidal voltage V(t) as a function of time. Considering the indicated voltage and time scales on the figure:

a. What are the amplitude, period, and frequency of this voltage?

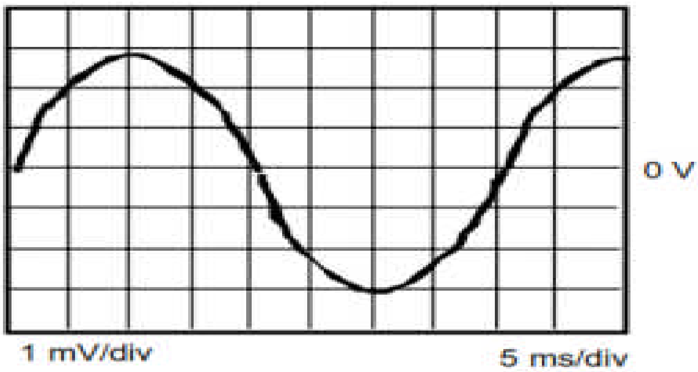


Figure 11

3.1. In-Person Work

1. **Setup 1**

a. Construct the circuit as shown in the following figure, using the following resistor values: R1=1 kΩ, R2=4.7kΩ; R3=10 Kω

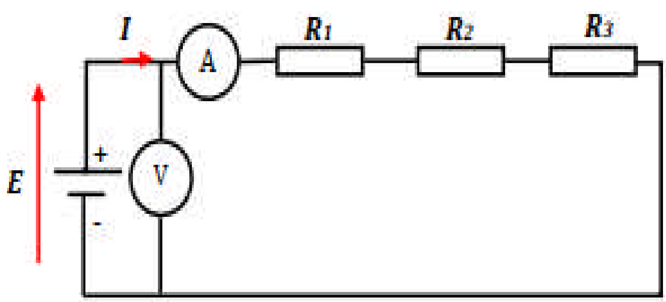


Figure 12

b. Measure the resistance values for R1,R2 and R3 using:

- The color code.
- An ohmmeter.

c. Using a voltmeter, measure and adjust the voltage E to 10 volts.

d. Using an ammeter, measure the current I.

e. Measure the following voltage drops: U1 across R1; U2 across R2; and U3 across R3 Verify the relationship:

E=U1+U2+U3,

f. Deduce the values of resistances R1R2 and R3 from the measurements obtained.

Compare these values with those found in part b.

2. **Setup 2**

   a. Construct the circuit as shown in the following figure, using the resistor values: R1=1 kΩ,R2=4.7 kΩand R3=10 kΩ

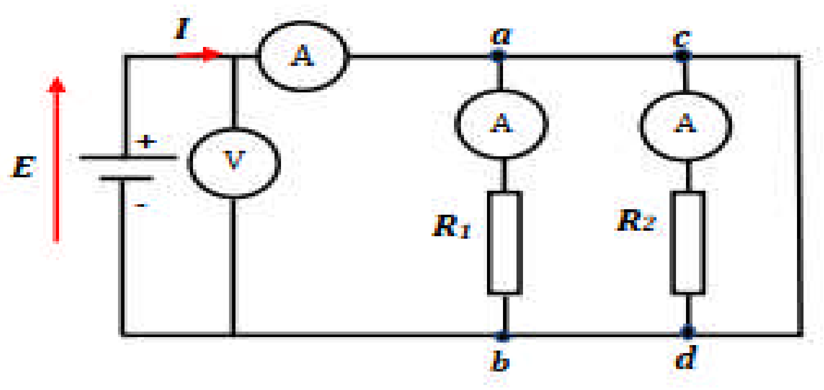


Figure 13

b. Using a voltmeter, measure and adjust the supply voltage E to 10 Volts.

c. With the voltmeter, verify that the voltage across each branch (between pointsab and cd) is equal to the supply voltage. Confirm the relationship: E=U1(ab)=U2(cd)

d. Utilize an ammeter to measure the current at the output of the power supply I, as well as the current in each branch (ab and cd). Verify the law of conservation of charge at the node.

3. Setup 3

a. Set up the wiring as shown in the diagram below:

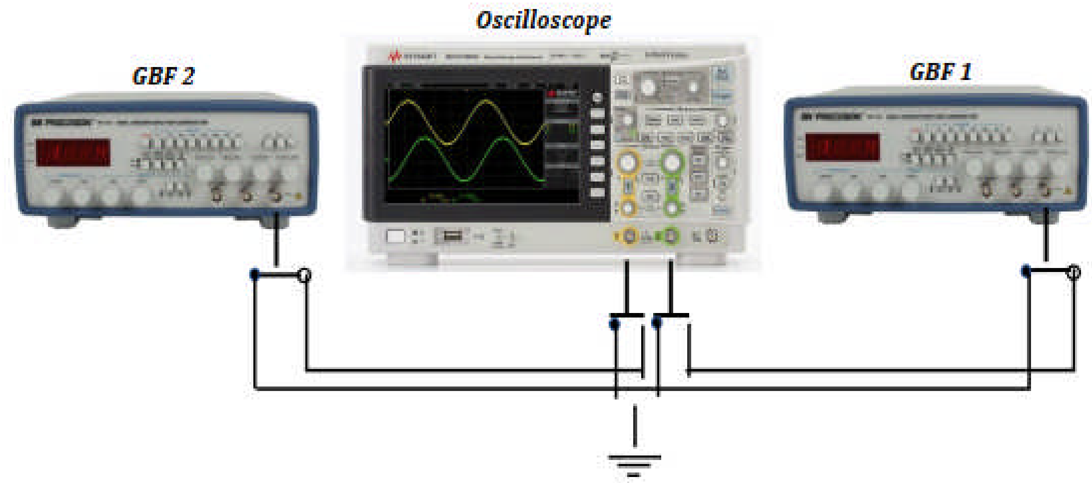


Figure 13

b. Using GBF 1, generate a sinusoidal signal.

c. Using GBF 2, generate a triangular signal.

d. Visualize both signals on the oscilloscope.

e. Adjust the amplitude of the sinusoidal signal to 5V and the amplitude of the triangular signal to 10V, ensuring both signals have a period Tof 0.001s.

f. Using the oscilloscope, create a phase shift of T/2 between the two signals.