People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

Mohamed Boudiaf University of M'sila

Faculty of Sciences

Common Trunk of Matter Sciences

1st year - 2nd semester

Practical works - Physics 2

1st Practical Work

Electrical Measuring Instruments

Experiment date : ………/………/……………

Corrector professor : ……………………………………

Report prepared by :

First name	Family name	Group	Sup-group	Preparation mark	Final mark
				/5,00	/20,00
				/5,00	/20,00
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				/5,00	/20,00
				/5,00	/20,00
				/5,00	/20,00

Academic year : 2023/2024

1. Purpose : The main objectives of this work are :

- Raise the characteristics of the different measuring instruments.
- Know how to use and handle a measuring instrument.
- Know how to perform a measurement setup for a given electrical quantity, such as voltage, current intensity, resistance, etc.

2. Preparation work :

a. Formulate the following definitions :

- The electrical voltage (U) is ....
  ....
- The electric current (intensity I) is ....
  ....
- The electrical resistance (R) is ....
  ....
- The electrical capacitance (C) is ....
  ....

b. Answer the following questions:

- What instrument is used to measure the value of " U " ? ....
- What instrument is used to measure the value of " I " ? ....
- What instrument is used to measure the value of " R " ? ....
- What is the relationship between: " U ", " I " and " R " ? ....
- What is an electrical multimeter ? ....
  ....
- What is a cathode ray oscilloscope (CRO) ? ....
  ....
- What is a low frequency generator (LFG) ? ....
  ....

3. Electrical measuring instruments :

3.1. Electrical Multimeter (figure 1)

① " On/Off " switch

② Function (and range) selector knob

③ Function (Voltmeter, Ammeter or Ohmmeter)

④ Measuring ranges

⑤ COM terminal (Negative terminal)

⑥ Positive terminals (depending on function)

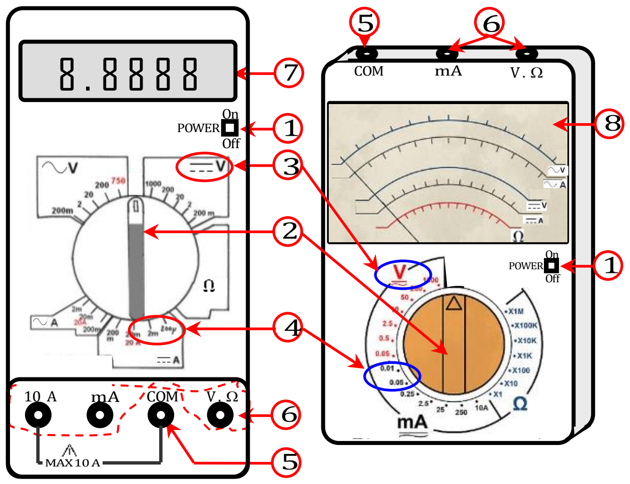
⑦ Display screen

⑧ Dial with needle

Figure 1 :

Digital multimeter

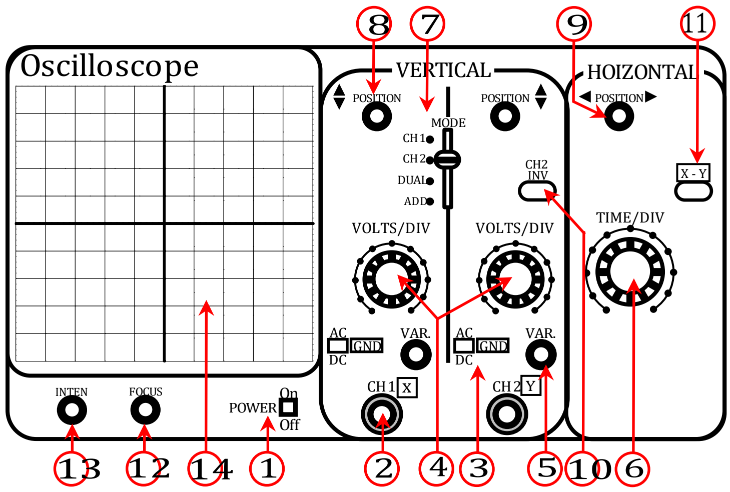
Analog multimeter



3.2. Cathode Ray Oscilloscope (CRO) [also known as oscilloscope] (figure 2)

1. " On/Off " switch
2. INPUT[CH1] terminal (X-axis input terminal)
3. Connection mode (AC,DC or GND)
4. Vertical sensitivity selector (Volts/Div)
5. Precise adjustment of vertical sensitivity
6. Horizontal sensitivity selector (Time/Div)
7. Operating mode selector
8. Vertical signal positioning control
9. Horizontal positioning control
10. " Trace signal [–CH1] " switch
11. " X–Y Mode " switch
12. Adjusting the spot size
13. Adjusting the light intensity of the spot
14. Fluorescent screen

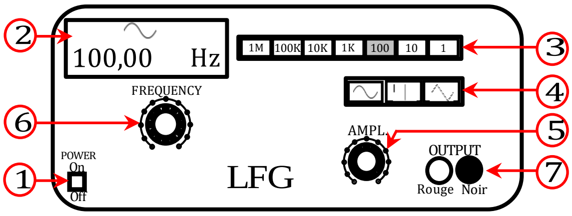
Figure 2:



3.3. Low Frequency Generator (LFG) (figure 3)

1. " On/Off " switch
2. Display screen
3. Setting the frequency range
4. Setting the signal type
5. Adjustment of the amplitude (the voltage delivered)
6. Frequency adjustment
7. Output terminal [Black=COM]

Figure 3 :



4. Practical work :

Experiment 1 : Verification of Ohm's law

- Draw the diagram of a simple circuit consisting of a direct current (DC) generator and a resistor , then add an ammeter (or Ampere meter) and a voltmeter .
- Set up this circuit using an analog multimeter as Ammeter and a digital multimeter as Voltmeter.
- Measure the voltage across resistor R . $U = ... V$
- Using these relationships : $\begin{cases} Measurement = \dfrac{Reading \times Range}{Scale's\ maximum} \\ Reading = Number\ of\ divisions \times Least\ count\ of\ scale \end{cases}$,

  measure the current in the circuit. $I = ... A$
- Applying Ohm's law, calculate the resistance R from the measured voltage and current values.

  $R_{calc} = ...\ \Omega$
- Use the digital multimeter as an Ohmmeter, and connect it directly to the resistor. Measure the resistance R . $R_{meas} = ...\ \Omega$
- Compare the calculated value with the measured value of the resistance. Conclude ?....................

  ....

Experiment 2 : Using an oscilloscope to Plot the signal of a DC voltage (a direct current)

Connect a voltmeter (digital multimeter) to the generator terminals (that was used in the previous experiment) .

- Measure the voltage delivered : $E = ... V$ (" E " is the electromotive force)
- Unplug the voltmeter, and connect the generator to the input of channel 1 (CH1) of an oscilloscope.
- Operate the oscilloscope, then set it (choose the light spot, the origin of the times).
- Plot the signal obtained, by putting the oscilloscope in the DC position, then in the AC position.
- Note your remarks and comments.

DC Position	AC Position	Remarks and results

Horiz. Sen. S_h=........ ms/div	Vert. Sen. S_v=......... V/div	Horiz. Sen. S_h=........ ms/div	Vert. Sen. S_v=......... V/div	....

Experiment 3 : Using an oscilloscope to plot the signal of an AC voltage (an alternating current)

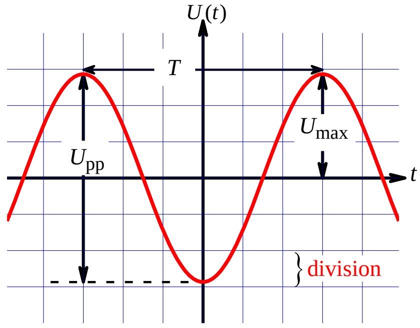
Reminder: if we apply to the oscilloscope input a signal U(t) and we obtain the graph below, we have:

- Peak-to-peak value : $U_{pp} = N_{div} \times S_v$
- Maximum value (Peak value or Amplitude) : $U_{max} = \dfrac{U_{pp}}{2}$
- Period : $T = N_{div} \times S_h$

Such as : N_{div} is the number of divisions

S_v is the vertical sensitivity (Volts/div)

S_h is the horizontal sensitivity (Time/div)



Connect the CH1 input of the oscilloscope to the terminals of a LFG generator .

- Apply an alternating voltage, of a frequency $f_{LFG} = 100$ Hz .
- Choose a sinusoidal signal, triangular and then square.
- Measure the applied voltage using a voltmeter. $U_{voltmètre} = U_{eff}$ (the effective voltage).
- Complete the following table :

	Sinusoidal signal		Triangular signal		Square signal	
	S_h=......... ms/div	S_v=......... V/div	S_h=......... ms/div	S_v=......... V/div	S_h=......... ms/div	S_v=......... V/div
U_{eff} (V)	....		....		....	
U_{max} (V)	....		....		....	
T (s)	....		....		....	
$\left(\dfrac{U_{max}}{U_{eff}}\right)^2$	....		....		....	

According to the results, what is the relationship between U_{eff} and U_{max} for the three signal modes :

- Sinusoidal signal : $U_{eff} =$........... U_{max}
- Triangular signal : $U_{eff} =$........... U_{max}
- Square signal : $U_{eff} =$........... U_{max}

<u>Experiment 4 :</u> ***Measurement of phase shift between two signals*** **(**voltage-current phase shift of an RC circuit**)**

Perform the setup of an RC circuit, and apply an alternating voltage of a frequency $f_{LFG} = 200$ Hz .

– Connect the inputs (CH1 and CH2) of the oscilloscope, as shown in the figure 4.

– Complete the table, and check the relationship between the shift phase $\Delta\varphi$, R, C and f ?

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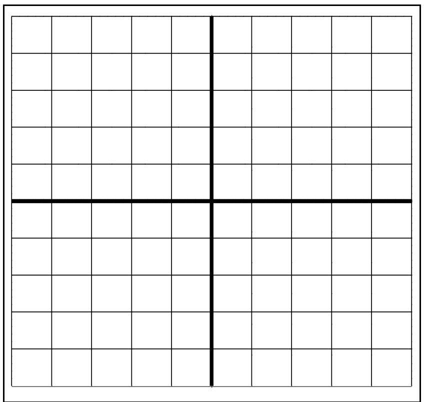
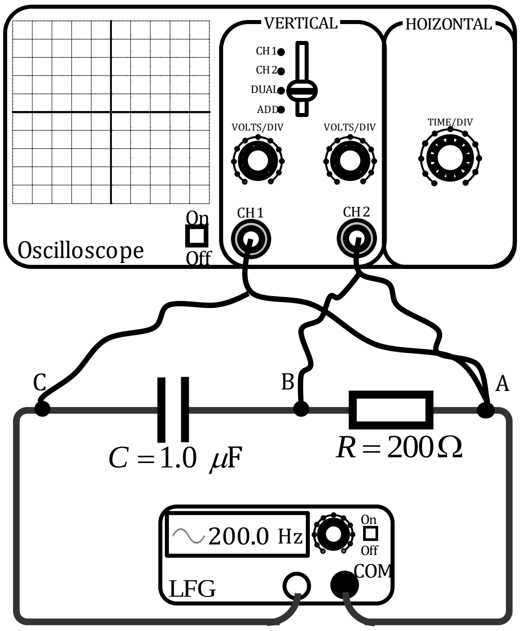


S_h=.......... ms/div S_v=........... V/div

AB (div)	....
$T = AB \times S_h$ (s)	....
MN (div)	....
$\Delta T = MN \times S_h$ (s)	....
$\Delta\varphi$ [rd]	....
$2\pi \times R \times C \times \tan(\Delta\varphi)$	....



<u>Figure 4</u>

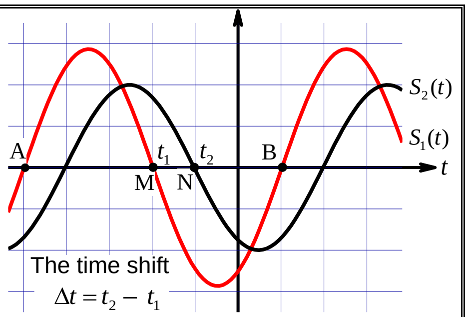
Reminder: Consider the two sinusoidal signals defined as follows:

$$\begin{cases} S_1(t) = S_{01} \cdot \sin(\omega \cdot t + \varphi_1) \\ S_2(t) = S_{02} \cdot \sin(\omega \cdot t + \varphi_2) \end{cases}$$

Such as : $\omega [s^{-1}]$: is the angular frequency of signals $\left(\omega = \dfrac{2\pi}{T} \right)$

φ_1 [rd] : is the phase of the signal $S_1(t)$

φ_2 [rd] : is the phase of the signal $S_2(t)$



The phase shift between the two signals S_1 et S_2 is defined by : $\Delta\varphi = \varphi_2 - \varphi_1 = 2\pi \dfrac{\Delta t}{T}$

5. Conclusion

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