

TP-2

CATHODIC OSCILLOSCOPE

(1st Part + 2nd Part)

1- The purpose

The goal of this experiment is to learn how to perform various signal measurements using the oscilloscope.

2- Reminder

The oscilloscope is a measuring instrument that allows you to visualize the variations of a voltage as a function of time or as a function of another voltage. It also enables the measurement of the frequency of alternating signals and the phase difference between two signals.

3- Measurement processes using the oscilloscope

3-1- Voltage measurement

To measure voltage using one of the two channels of the oscilloscope, it is advisable to select a range in such a way that the peak-to-peak amplitude of the signal occupies most of the screen without overshooting (to reduce potential sources of error).

Example of measurement

Consider a sinusoidal signal $V_e(t)$ applied to channel 1 of the oscilloscope with the range selector set to 0.5 V/cm. Its peak-to-peak value is:

Its peak-to-peak value is:

$$V_{e_{cac}} = \text{Number of Cm (Nb)} \times \text{scale (K}_V) = \text{Nb} \times K_V$$

$$V_{e_{cac}} = 4 \text{ Cm} \times 0.5 \text{ V/Cm} = 2 \text{ V Peak-to-peak (càc)}$$

$$V_{e_{max}} = 2 \text{ V} / 2 = 1 \text{ V}$$

3.2 Frequency measurement

To measure the frequency of a signal, choose a time-based setting such that the period of the signal occupies the majority of the horizontal length of the screen.

Example of measurement

Consider a signal V_e applied to channel 1 of the oscilloscope, where the time base range selector is set to 0.5 ms/cm.

$$T = \text{Nb de cm (Nb)} \times \text{scale (K}_s) = \text{Nb} \times K_s$$

$$T = 10 \text{ cm} \times 0.5 \text{ ms/cm} = 5 \text{ ms} = 5 \cdot 10^{-3} \text{ s}$$

$$\text{Hence, } f = 1/T = 0,2 \times 10^{-3} = 200 \text{ Hz.}$$

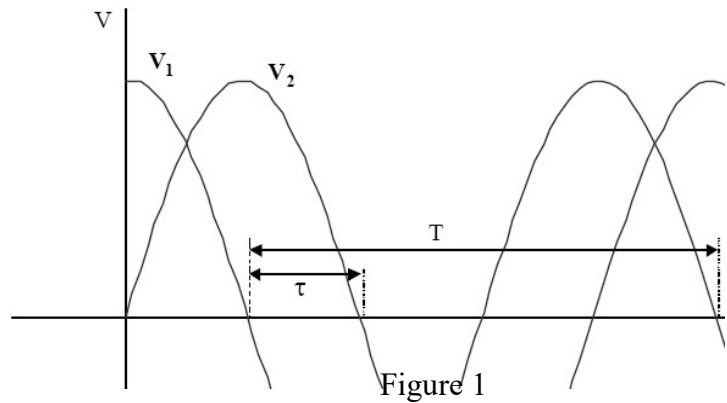
3.3 Phase measurement

To measure the phase difference between two signals, it is necessary to observe them simultaneously. For this purpose, both voltages should be referenced to the same point, which is the ground point.

First method: direct method

Consider two signals with a phase difference; the phase shift (in degrees) is:

$$\varphi = \frac{t}{T} \times 360^\circ$$



Measurement Example:

Consider two signals V_e and V_s , where V_s is phase-delayed compared to V_e . Reading from the screen: $T = 10 \text{ cm}$ and $t = 2.5 \text{ cm}$.

Therefore $\varphi = \frac{t}{T} \times 360^\circ = \frac{2.5}{10} \times 360^\circ = 90^\circ$

Second method: Lissajous method (two signals of the same frequency)

This method involves obtaining curves in a plane by displacing a plane whose coordinates are functions of the same parameter.

To use this method, set the oscilloscope to a horizontal sweep.

Note: Before taking measurements, position the spot at the center of the axes (center of the screen).

$$X = V_e(t) = A \sin(\omega t)$$

$$Y = V_s(t) = B \sin(\omega t + \varphi)$$

With: $a = 2Y_{X=0}$ et $b = 2Y_{\text{max}}$

It is shown that: $\sin(\varphi) = a/b$ donc: $\varphi = \arcsin(a/b)$

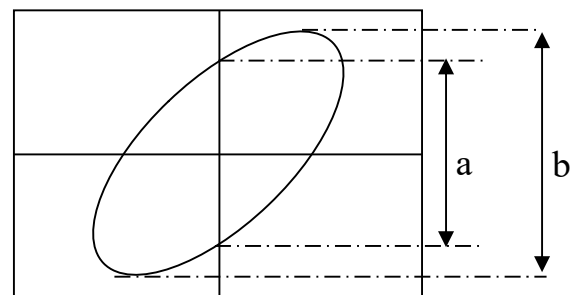


Figure 2

Measurement Example:

Consider the ellipse below where:

$$a = 4 \text{ div} \text{ et } b = 6 \text{ div}$$

So: $\sin \varphi = a/b = 4/6 = 0.66$

Hence: $\varphi = \arcsin(0.66) = 0.72 \text{ rad}$

$$0.72 \text{ rad} = 41^\circ$$

This method does not provide information about the direction of the phase shift.

4- Necessary equipment

| | |
|-------------------------------------------|------------------------|
| 01 Oscilloscope | 01 Variable Resistor |
| 01 Voltage Generator | 02 Fixed Resistors |
| 01 Low-Frequency Signal Generator (GBF) | 01 Capacitor |
| | 01 Voltmeter |

MANIPULATION

1- Amplitude measurement

Using the voltage generator, apply an alternating voltage to the input of channel 1 on the oscilloscope:

- Complete table 1.
- Record the signal point by point on graph paper for one of the values.
- Interpret the results.

| | | | |
|-------------------------------------|---|---|----|
| V (Generator) | 2 | 8 | 15 |
| Scale(Caliber) V/Cm | | | |
| Nb. of Cm peak to peak | | | |
| V peak to peak (V) | | | |
| $V_{max} = V_{c\grave{a}c} / 2$ (V) | | | |
| V on the voltmeter (V) | | | |
| $V_{eff} = V_{max} / \sqrt{2}$ (V) | | | |

Table 1

2- Visualization of two voltages

The oscilloscope also allows the visualization of two voltages. To achieve this, activate the button that selects both channels.

-Make the connections as shown in Figures 1 and 2.

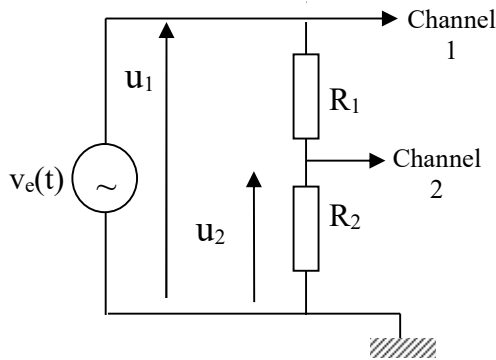


Figure 3a

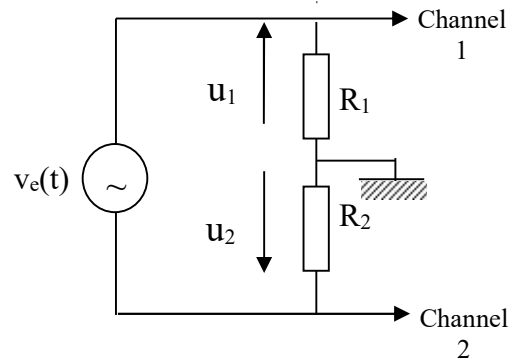


Figure 3b

- Plot for both configurations u_1 and u_2 when:
 - $v_e(t)$ is alternating voltage.
 - $v_e(t)$ is direct voltage.
- What can we conclude?

3- Frequency Measurement

Using the GBF, apply a sinusoidal, square then triangular signal to the input of channel 1 of the oscilloscope: complete table 2.

| Signal | Sinusoidal | Square | Triangular |
|-------------------------|------------|--------|------------|
| F (Hz) displayed on GBF | 200 | 500 | 1000 |
| Time base setting ms/cm | | | |
| NB. of Cm per period | | | |
| T(s) | | | |
| $F=1/T$ (Hz) | | | |

Table 2

- Interpret the results.

4-PHASE SHIFT MEASUREMENT

4.1. Direct method.

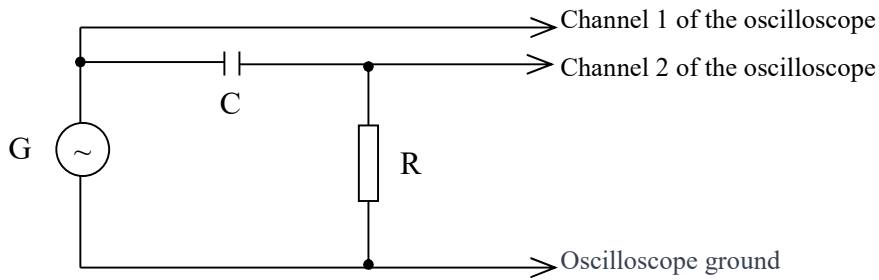


Figure 4

- Assemble the setup shown in Figure 4,
G is an alternating voltage generator set at **6V**,
C is a capacitor with a value of **1μF**,
R is a variable resistor.
- Adjust the resistance according to Table 3 and determine the phase shift for each value of R.

| | | | |
|-------------------------------------|---|---|---|
| R(KΩ) | 2 | 4 | 8 |
| T(cm) | | | |
| t(cm) | | | |
| $\varphi = (t / T) \cdot 360^\circ$ | | | |

Table 3

- Interpret the results.

4.2. Lissajous method

For the same setup as that in Figure 4, determine the phase shift according to Table 4.

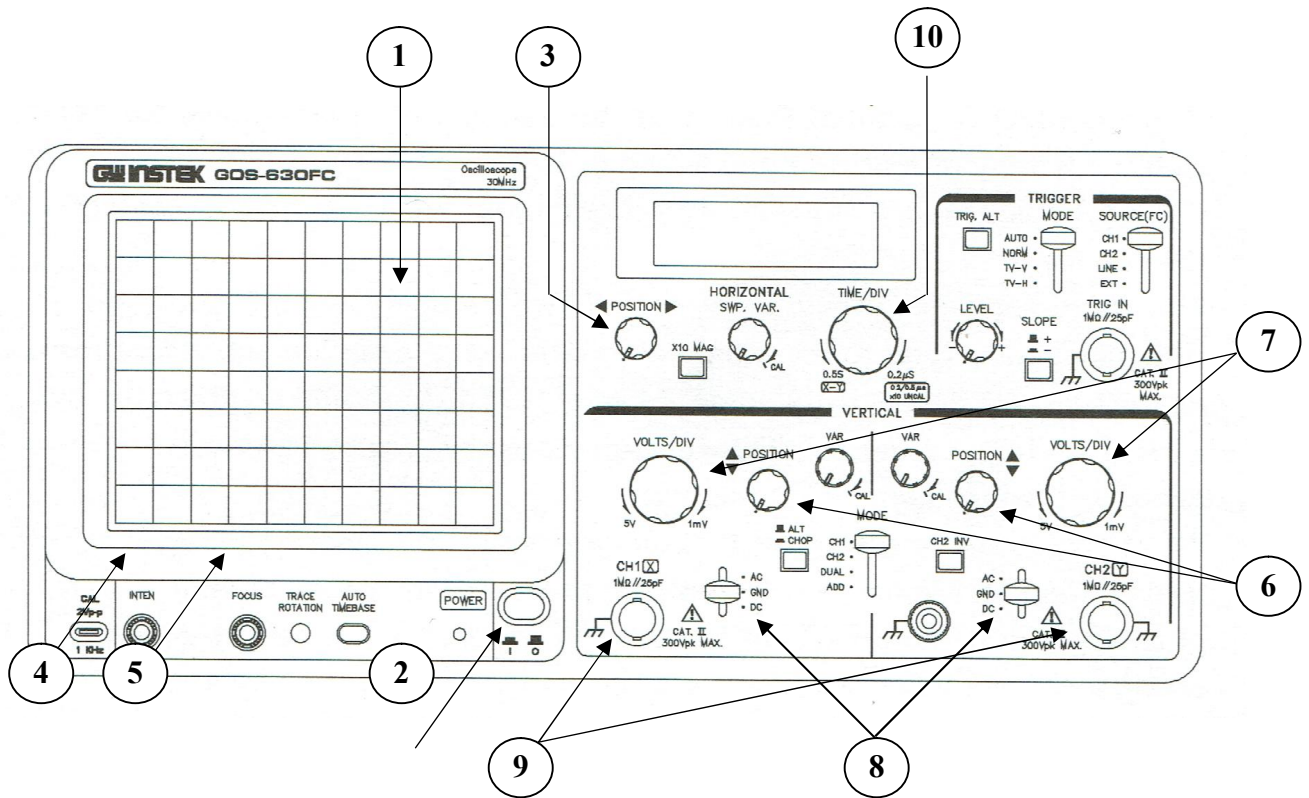
| | | | |
|-----------------------------------|---|---|---|
| R(KΩ) | 2 | 4 | 8 |
| a(cm) | | | |
| b(cm) | | | |
| $\sin \varphi = a/b$ | | | |
| $\varphi = \arcsin(a/b) (^\circ)$ | | | |
| φ (rad) | | | |

Table 4

- Interpret the results.
- What happens to the phase shift if R increases indefinitely?

Annex

Cathode Oscilloscope



- 1- Screen.
- 2- Power On/Off Button.
- 3- Horizontal (X) Adjustment.
- 4- Light intensity.
- 5- FOCUS (Sharpness).
- 6- Adjustment of the ordinates (Y).
- 7- Amplitude Scale Selector Switch (V/Cm).

- 8- Switch (AC/DC/GND).
GND : Ground.
DC : Direct current.
AC : Alternating current.
- 9- Inputs (Channels I, II).
- 10- Time Base.

| | | |
|------------|---------------------|--|
| Gr: | First name : | |
| | Last name: | |
| | N° | |

TP N°2 – Cathode Oscilloscope

Measurement of amplitude and frequency of an alternating voltage

I. Amplitude measurement

1. Procedure for calculating V_{cac} , V_{max} and V_{eff}

V_{cac} =

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V_{max} =

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V_{eff} =

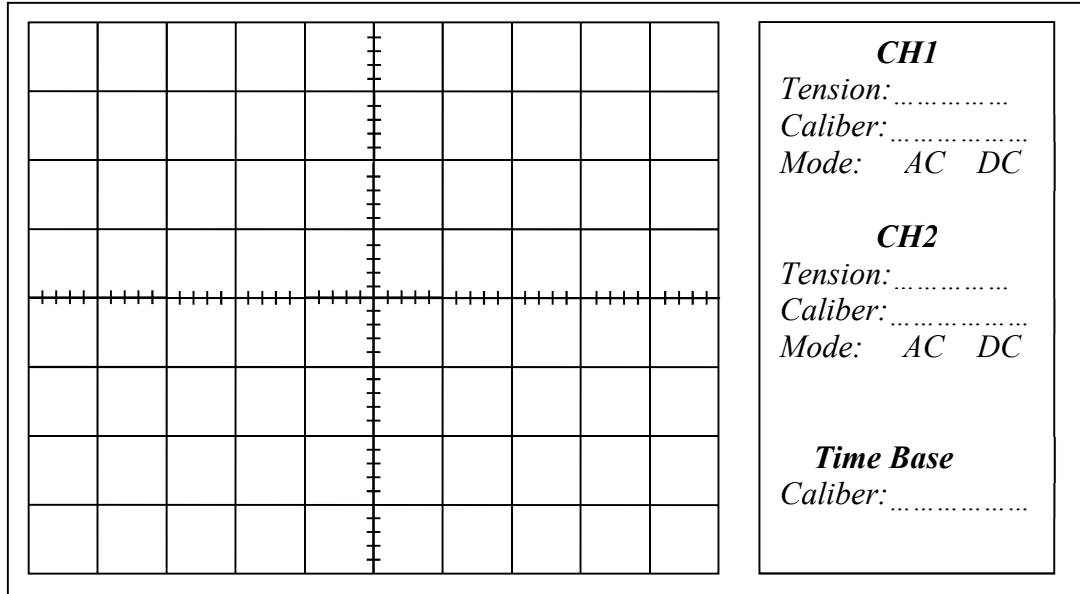
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2. Complete the table below

| | | | |
|----------------------------------|--|--|--|
| $V_{Generator}$ () | | | |
| $V_{Voltmeter}$ () | | | |
| Scale (Caliber) K () | | | |
| Nb of cm peak to peak. | | | |
| V_{cac} () | | | |
| $V_{max} = V_{cac}/2$ () | | | |
| $V_{eff} = V_{max}/\sqrt{2}$ () | | | |

3. Graph



4. Interpretation

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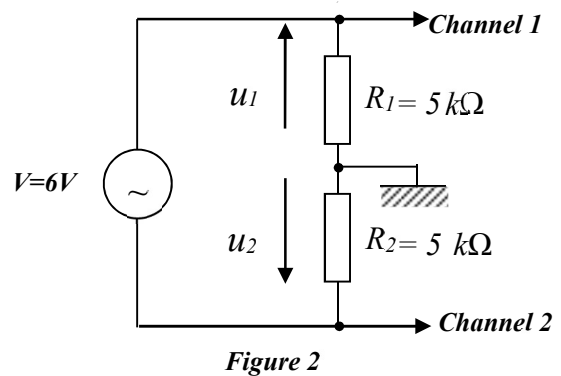
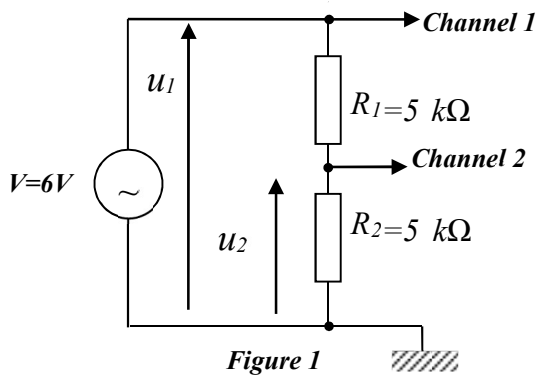
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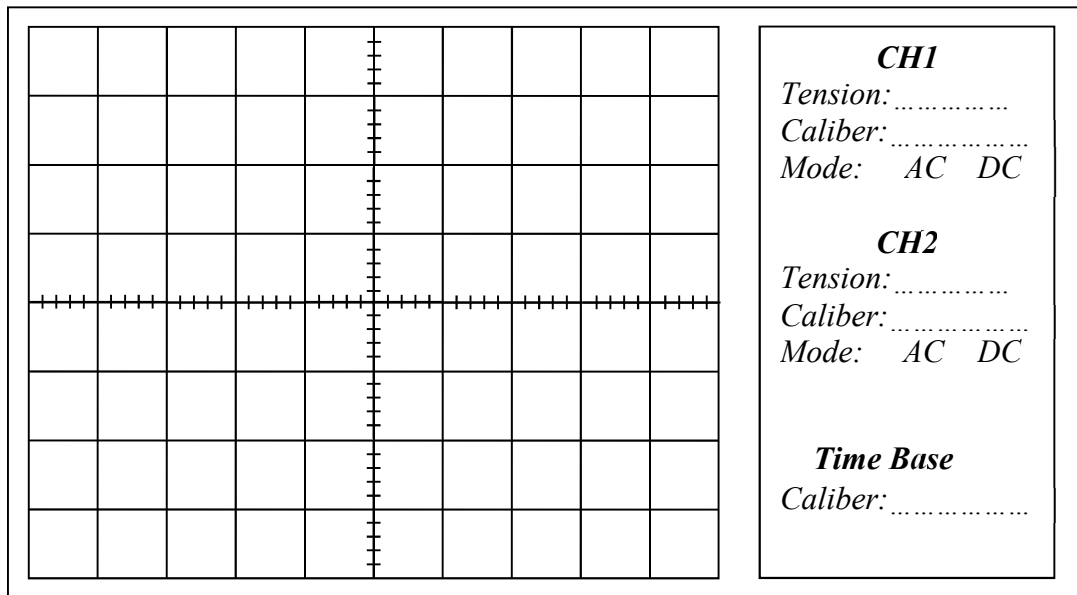
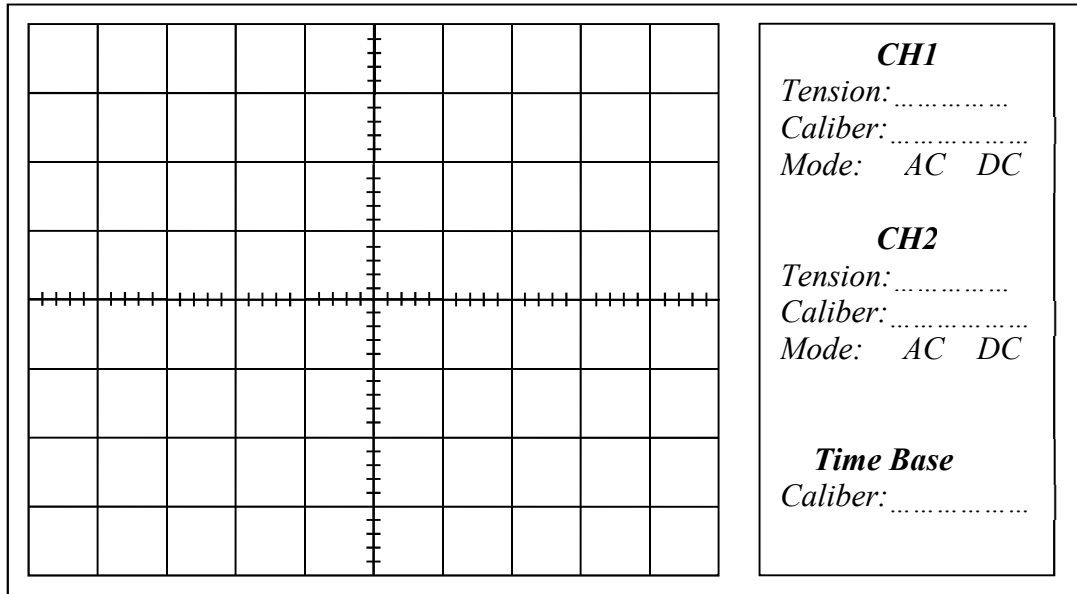
II. Visualization of two tensions

Study the two assemblies below and trace the voltages u_1 and u_2 knowing that:

$$v(t) = 12\sqrt{2} \sin 100\pi t \quad (V)$$



1. Graphs



2. Interpretation

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3. Give the expressions of u_1 and u_2 knowing that $v(t) = 12 (V)$

| | u_1 | u_2 |
|-----------------|-------|-------|
| Figure 1 | | |
| Figure 2 | | |

III. Frequency measurement

1. Procedure for calculating the period T and the frequency f

$T =$

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$f =$

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2. Complete the table below :

| Signal waveform | Sinusoidal | Square | Triangular |
|-------------------------------------------|------------|--------|------------|
| Frequency displayed by the GBF F (Hz) | 200 | 500 | 1000 |
| Calibre base de temps K_s () | | | |
| Number of cm on a period Nb | | | |
| Period T () | | | |
| Frecuency $F = 1/T$ () | | | |

Interpretation

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IV. Conclusion

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