Lab Report: Electrical Circuits (CSE 209)

Expt. No: 08

Title: Experimental Study of Sinusoids and Their Characteristics.

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Objectives:

1. To observe the sinusoids in the oscilloscope using a simple RC circuit.

2. To read characteristics of the sinusoid from the oscilloscope and match the values with their corresponding measured values.

Theory:

Any sumusoid (voltage or current) is a periodic function of time and has positive value for half of the period and negative value for the rest half of the period. It is characterized by three parameters: (1) amplitude. (m frequency, and (in) phase. A voltage sinusoid with amplitude . period (11/7). and phase O is shown in Figure 1. This can be mathematically expressed as (1) = sin(er+e). Where w = 27 . The RMS value of the voltage sinusoid is.Using AC volmetet and ammeter, we can measure the RMS value of a sinusoid.

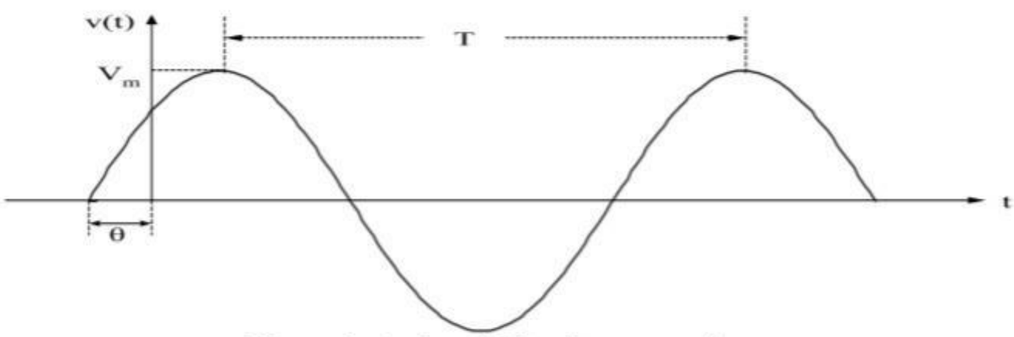

Figure 1. A sinusoidal voltage waveform.

Measurement of Phase Difference in Oscilloscope

The phase difference between two sinusoids (like voltage and current) can be measured in the oscilloscope by observing them in the dual mode. For this, observe one sinusoid in channel-1 and the other in channel-2. Turn on the cursor that measure AT and place them between the adjacent peaks of the two sinusoids as shown in Figure 2. Measure At as shown in Figure 2. Now turn off either channel-1 or channel-2 and observe one sinusoid. Measure the time period T as shown in Figure 1. Calculate the phase difference in degree between the two sinusoids from 10 = At*360" T or 10 = At*360*f.

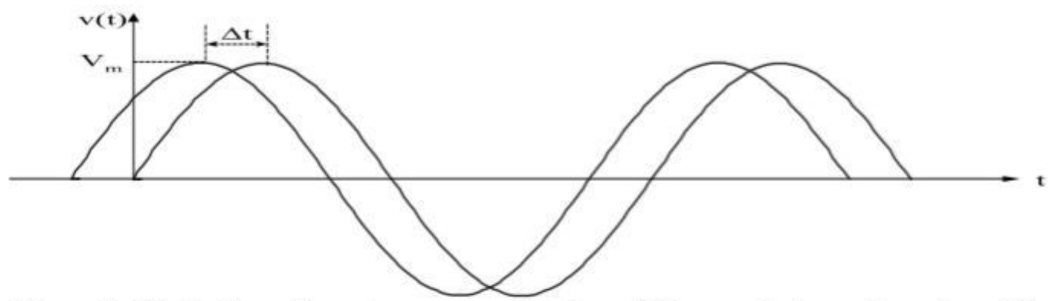

Figure 2. Illustration of how to measure the phase difference between two sinusoids.

Impedance:

Once you measure the amplitudes of the voltage and the current sinusoids and the phase difference between them, you can calculate the impedance of the circuit from Z=

Circuit Diagram:

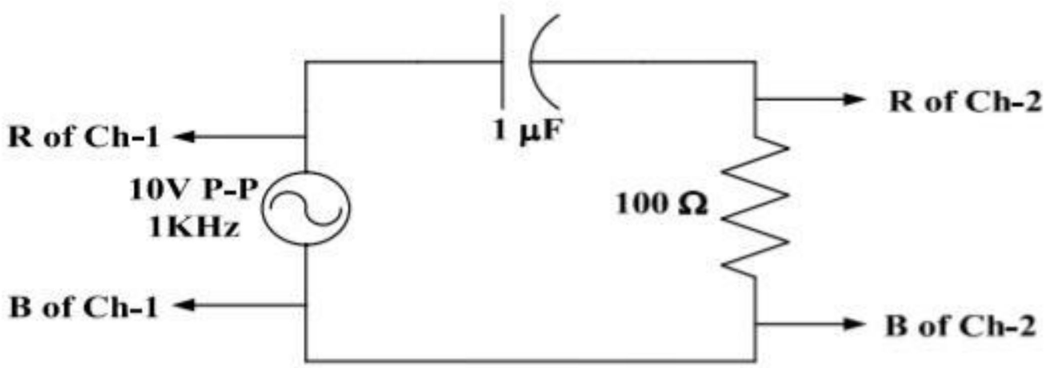

Figure 3. Circuit diagram for experiment.

Pre-Lab Report Quesstion:

Step 1: Calculate the Impedance

Capacitive Reactance:

The capacitive reactance (Xc) is given by the formula $Xc = 1 / (2\pi fC)$, where f is the frequency and C is the capacitance.

$Xc = 1 / (2\pi * 1000 \text{ Hz} * 1 \mu F)$

$Xc \approx -159.15 \ \Omega$

Total Impedance:

The total impedance (Z) is the combination of the resistance (R) and the capacitive reactance (Xc). We use the formula $Z = \sqrt{(R^2 + Xc^2)}$.

$Z = \sqrt{(100^2 + (-159.15)^2)}$

$Z \approx 187.96 \ \Omega$

Step 2: Calculate the Current Amplitude

Peak-to-Peak Voltage to RMS Voltage:

The peak-to-peak voltage (Vpp) is given as 10 V. To find the RMS voltage (Vrms), we use the formula $Vrms = Vpp / (2\sqrt{2})$.

$Vrms = 10 \text{ V} / (2\sqrt{2})$

$Vrms \approx 3.536 \text{ V}$

Ohm's Law:

The current (I) is given by the formula $I = Vrms / Z$.

$I = 3.536 \text{ V} / 187.96 \ \Omega$

$I \approx 18.81 \text{ mA}$

Step 3: Calculate the Phase Difference

Phase Angle: The phase angle (Φ) is given by the formula $\Phi = \arctan(Xc / R)$.

$\Phi = \arctan(-159.15 \ \Omega / 100 \ \Omega)$

$\Phi \approx -57.87°$

Solution:

The amplitude of the current flowing through the circuit is approximately 18.81 mA.The phase difference between the current and the input voltage is approximately -57.87°, meaning the current leads the voltage by 57.87°.

Table1.Experimental Data From Oscilloscope

Measured value of Resistance(ohm)	Set peak-to-peak value of source voltage (V)	Set source frequency(KHz)	Measured peak value of current through resistance(mA)	Measured phase difference between voltage and current (deg)	Which signal is leading?
97	10.2	0.997	26.39	61.015	Channel-2

Table 2: Experimental Data from Meter Reading

Measured RMS value of source voltage(V)	Measured RMS value of voltage across capacitor(V)	Measured RMS value of voltage across resistance(V)	RMS value of current through resistance (mA)
3.25	1.33	1.92	19.7

Post-Lab Report Quesstions:

<u>Answer no 01.</u>

(i)

The peak amplitude is half of the peak-to-peak value:

Vpeak =Vpp/2=10.2/2=5.1V

(ii)

The theoretical RMS value for a sinusoidal signal is:

Vrms(calculated)=Vpeak/√2 =5.1/√2 =3.61V

(iii)

Compare with measured RMS value:

Difference=Vrms(measured)-Vrms(calculated)=(5.1-3.61)V

So,Diference= 1.49V

(iv)

Compute the percentage difference:

Percentage Difference={Difference\Vrms(measured)}×100=(1.49/5.1)×100=0.29×100=29%

Answer no 02.

Amplitude of current (oscilloscope):

26.39mA

RMS value:

Irms=26.39/√2 =18.66*mA*

Measured RMS current (Table 2): 19.7mA

Again, compared the two values.

Answer no 03.

Measured RMS value of voltage, Vrms = 3.25V

Measured RMS value current, Irms =26.39/√2 =18.66mA=0.0188A

We know,

Magnitude, $|Z|=V_{RMS}/ I_{RMS}$= 174.17Ω

Phase angle θ= 61.015 Degree

$R=|Z|\cdot\cos(\theta) = 174.17\times0.485 \approx 84.47\Omega$

$X_C =|Z|\cdot\sin(\theta) =174.17\times0.875 \approx 152.40\Omega$

Impedance, $Z = R\text{-}jXC$

$=84.47\ \Omega- j154.40\Omega$

Answer no 04.

Impedance angle, θ= tan-1(XC /R)

= tan-1(152.40/84.47)

= 61°

Impedance angle : Phase angle = 1:1.0002

Discussions!

1. It is needed to ensure precise measurement of amplitude, frequency, and phase to get reliable data.

2. It should ~~used~~ be used a stable power source to avoid fluctuations that could affect the sinusoidal wave's accuracy.

3. All equipments should be established properly to prevent electrical hazards and measurement errors.

4. All the variables should be labelled clearly (like amplitude, frequency, phase) to avoid confusion when analyzing results.

5. Correct wave form should be selected on the generator to avoid confusion in analysis.