BRAC UNIVERSITY
Department of Electrical and Electronic Engineering
Course No.: CSE250

Experiment 8

Name of the Experiment:

Familiarization with the alternating current (AC) waves

Objective:
In this experiment, we shall study some aspects of sinusoidal waveform, and correlate these with practically measurable values such as- rms. value (also called effective value), phase angle and time period. Also an exposure to simple ac circuit and some circuit elements are made. Try to familiarize yourself with

- Oscilloscope
- How to measure peak value, phase angle and time period (or frequency) using oscilloscope
- The methods of measuring rms. value both using oscilloscope and multimeter
- Difference between AC & DC setting of multimeter & oscilloscope
- Capacitor, resistor and breadboard

Introduction:
Any periodic variation of current or voltage where the current (or voltage), when measured along any particular direction goes positive as well as negative, is defined to be an AC quantity. Sinusoidal AC wave shapes are the ones where the variation (current or voltage) is a sine function of time.

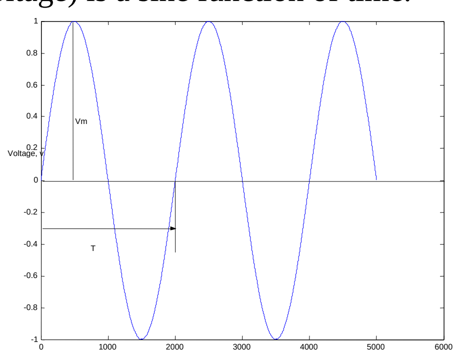

Figure 1(a): AC Voltage waveform

Here, Time period = T, Frequency, $f = \frac{1}{T}$.

$v(t) = V_m \sin(2\pi ft)$

Effective value:

The general equation of rms. value of any function (voltage, current or any other physical quantity for which rms. calculation is meaningful) is given by the equation,

$$V = \sqrt{\frac{1}{T}\int_0^T v^2 dt}$$

Now, for sinusoidal functions, using the above equation we get the rms. value by dividing the peak value (V_m) by square root of 2. That is,

$$V = \sqrt{\frac{1}{T}\int_0^T (V_m \sin(2\pi f t))^2 dt}$$

$$= \sqrt{\frac{1}{2\pi}\int_0^{2\pi} (V_m \sin(\theta))^2 d\theta} = \frac{V_m}{\sqrt{2}}$$

Similarly, for currents, $I = \frac{I_m}{\sqrt{2}}$. These rms. values can be used directly for power calculation. The formula for average power is given by Pavg = $\frac{1}{T}\int_0^T (vi)dt$. And for sinusoids this leads to $P_{avg} = VI\cos(\theta)$. Here, V and I are rms values and θ is the phase angle between voltage wave and current wave. The phase angle is explained in the next section.

Phase Angle:

Phase difference between two ac sinusoidal waveforms is the difference in the electrical angle between two identical points of the two waves. In figure 2, the voltage and current equations are given as:

$V = V_m \sin(2\pi \text{ft})$
$I = I_m \sin(2\pi \text{f.t} - \theta)$

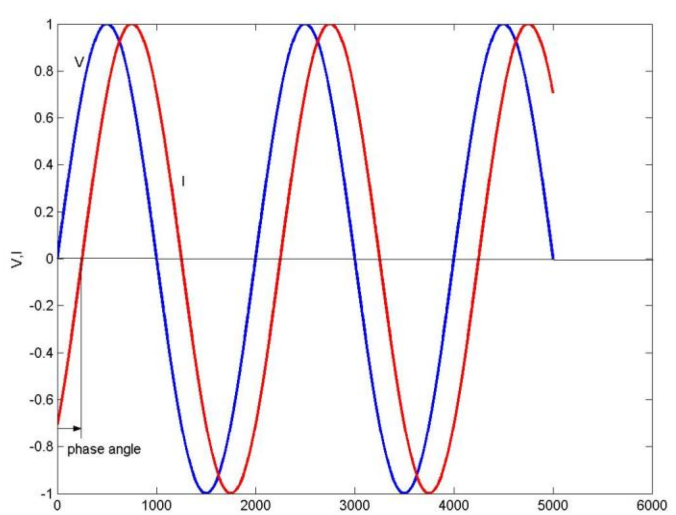

Fig 1(b): Two sinusoidal waves with phase difference

Impedance:

For, ac circuit analysis, impedance plays the same role as resistance plays in dc circuit analysis. It can be stated fairly safely that, the concept of impedance is the most important thing that makes the ac analysis so much popular to the engineers. As you will see in your later courses, any other periodic forms of time varying voltages or currents, are converted into an equivalent series consisting of sines and cosines (much like any function can be expanded by the power series of the independent variable using the Taylor series), only because the analysis of sinusoidal voltages are very much simple due to the impedance technique.

What is impedance anyway? Putting it simply, it is just the ratio of rms voltage across the device to the rms current through it. That is:

$$Z = \frac{V}{I\angle\theta} = \frac{V_m}{I_m\angle\theta}$$

Its unit is ohms.

Equipments:

1. Oscilloscope
2. Function generator (used as ac source)
3. Resistors : 1k, 220 Ω
4. Capacitor : 1 μ f
5. Multimeter
6. AC ammeter
7. Switch : SPST
8. Breadboard

Circuit Diagram:

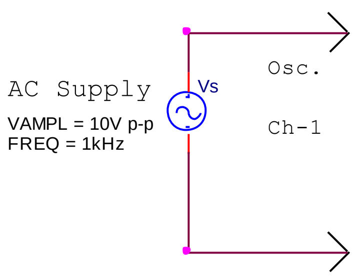

Figure-2

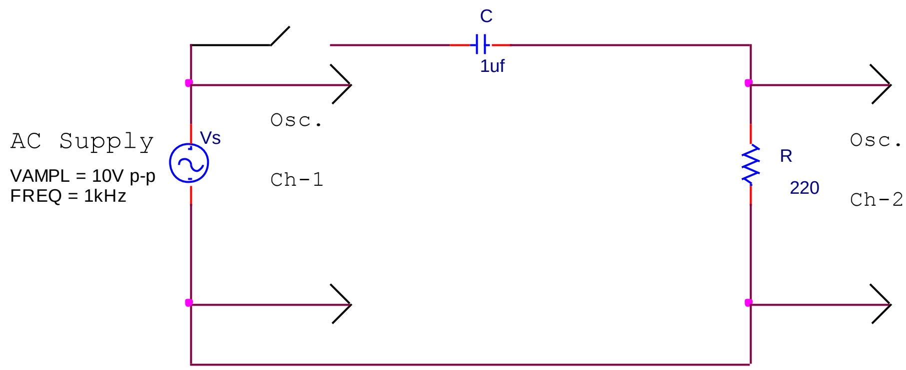

Figure 3

Procedure:

1. Connect the output of the function generator directly to channel 1 of the oscilloscope as shown in figure 2. Set the amplitude of the wave at 10v peak to peak and the frequency at 1 kHz, Select sinusoidal wave shape.

2. Sketch the wave shape observed on the oscilloscope. Determine the time period of the wave and calculate the frequency.

3. Measure the voltage with an ac voltmeter.

4. Change the frequency to 500 Hz and note what happens to the display of the wave. Repeat when the frequency is increased 2 kHz.

5. Construct the circuit as shown in figure 3. Measure the input voltage with multimeter with ac voltage mode and the input current, with an ac ammeter. The ratio between the voltage to the current gives the magnitude of the impedance Z.

6. Observe the wave shapes in channel 1 and 2 **simultaneously**. Find the frequency of both the waves (are they equal to the supply frequency) and their amplitude from the display. The phase difference is given by **360f.t degree**, where 't' is the **time delay** between the two waves. Note that the voltage in channel 2 is the voltage across a resistance and hence this is in phase with the current flowing in the circuit.

Report:

1. Compare the frequency of the wave determined from the oscilloscope in step 2 of the procedure with the mentioned value on the function generator.

2. Calculate the rms value of the voltage observed in step 2 of the procedure and compare with that measured in step 3.

3. How does the time period vary when the frequency of the wave is changed in step 4?

4. Calculate the magnitude of the impedance from the readings taken in step 5.

5. Find the magnitude and phase angle of the impedance from the readings taken in step 5 and 6.