EET 1150

1. LAB NUMBER: 1

2. TITLE: Basic AC Measurements with Oscilloscope

3. OBJECTIVES:

After completing this lab, the student will be able to:

a) use an oscilloscope to determine various parameters of a sine wave,
b) measure phase shift,
c) use a DMM to measure AC voltage.

4. EQUIPMENT:

METEX MS-9150 Generator
DMM
Oscilloscope
Experimenter board

5. COMPONENTS:

1 - 510 Ω ½ watt 5% Resistor
1 - 33 nF Capacitor

6. TEXT REFERENCE:

Circuit Analysis: Theory and Practice (5^{th} Edition):
A.H. Robbins and W.C. Miller

Section 15.4: Frequency, Period, Amplitude and Peak Value
Section 15.6: Voltages and Currents as Functions of Time
Section 15.7: Introduction to Phasors
Section 15.9: Effective (RMS) Values
Section 15.11: AC Voltage and Current Measurement.

Manual Appendix: Oscilloscope Basic

7. PRE-LAB ASSIGMENT:

Do the following calculations to prepare for this Lab. Attach your answers at the end of your team's Report as an Appendix.

a) The AC waveform that you will observe on the Oscilloscope can be described by the following sinusoidal function:

$$v(t) = 4 \sin(2\pi \times 1000t + 0°)\ V$$

From this function, deduce the parameters in Table 1.

Table 1:

Vm (volt)	Vp-p (volt)	f (Hz)	T (msec)

b) Calculate and record the instantaneous values of v(t) at various values of t in Table 2.

Table 2:

t (μsec)	0	100	200	300	400	500	600	700	800	900	1000
v (volt)											

c) The number of cycles of the above sine wave that you can observe on the oscilloscope depends upon the horizontal time base setting. Determine the number of cycles for the settings in Table 3.

Table 3:

Time base setting	No. of cycles
100 μsec/div	
200 μsec/div	

d) Two sine waves having the same frequency f (period T) are shifted on the oscilloscope screen by a distance dx. Write a formula that allows you to determine the shift angle **θ** (deg) from **dx** and **T**:
(Note: dx and T must have the same unit)

Table 4:

θ (deg) = --------- X

8. MEASUREMENTS:

A – Observing Sine Wave on Oscilloscope:

a) Locate the Signal Generator on the METEX. Select Sine Wave output. Identify the Amplitude control (AMP) and the Frequency Controls. Turn the AMP completely counter-clockwise to reduce the output to zero. Set the frequency to 1 kHz. Use the bottom BNC connector as the output. Connect a BNC-Alligator Clips cable to this output. Connect a probe to Channel 1 and to the output cable (Black clips together).

b) Set the Horizontal time base to 0.1msec/div (or 100 μsec/div) and the Vertical sensitivity to 1V/div. Set Input Coupling to AC and Trigger to + slope of CH1. Use the Vertical Position to center the trace.

c) Turn the AMP clockwise to see a sine wave on the oscilloscope. Increase AMP until the sine wave has a Vp-p of 8 divisions (complete screen height).

d) How many cycles of the sine wave do you see?

e) Measure the parameters in Table 5: "f" can be read from the display of the METEX.

Table 5:

Vm (volt)	Vp-p (volt)	f (Hz)	T (msec)

f) Compare Table 5 to Table 1.

g) Measure and record the instantaneous values of v(t) at various values of t in Table 6.

Table 6:

t (μsec)	0	100	200	300	400	500	600	700	800	900	1000
v (volt)											

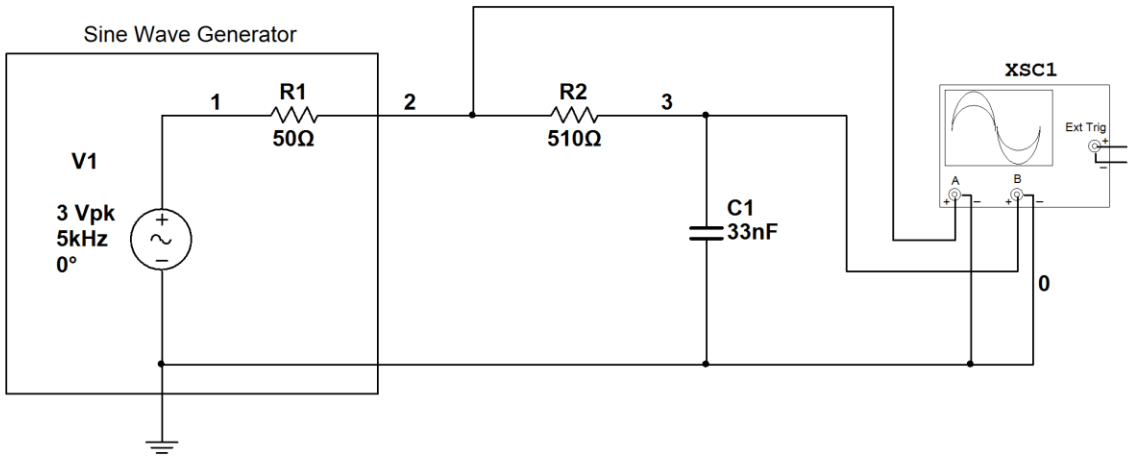
h) Compare Table 6 to Table 2.

i) Change the Horizontal time base to 200 μsec/div. Note the number of cycles displayed. Compare to your answer in Table 3.

B- Phase Shift Measurement:

j) Build the circuit of Fig. 1. The resistor and capacitor are used to generate two sine waves (at point "2" and "3") having the same frequency (5 kHz) but shifted by an angle θ. The 50 ohm resistor represents the internal output resistance of the generator which can be set by a front panel switch. Identify this switch and set it correctly.

Figure 1:



k) Set the oscilloscope in dual channel mode (you may need the instructor's help) with CH1 (A) connected to point "2" and CH2 (B) to point "3". Both ground clips are to be connected to the black clip of the sine wave generator. Center both traces.

l) Set the sine wave to 3V peak at 5 kHz on CH1. Change the Horizontal time base to display one cycle on CH1.

m) Measure the distance dx (in μsec) and the period T (μsec) then use the formula in Table 3 to calculate the phase shift in degrees.

n) Which waveform is leading (CH1 or CH2)?

C – Frequency Response of DMM:

o) Set the DMM to measure AC voltage. Note that the readings are in RMS values. Connect the DMM between points "2" and "0" (Ground) of Fig. 1. The DMM will measure the output voltage of the sine wave generator.

p) Measure the output voltage (Vm) using both the DMM and Oscilloscope (CH1) for 3 frequencies. Record your results in Table 7.

Table 7:

Frequency (kHz)	Oscilloscope (V – Peak)	DMM (V – RMS)
5		
10		
100		

q) Convert Oscilloscope readings to RMS and compare them to those of DMM.

9. LAB REPORT REQUIREMENT:

Your team's Lab Report should contain the followings:

A Cover Page with Lab Number, Lab Title, Team members' Names and Date.
An Introductory Page with list of Equipment and Components used.

Result Pages with:

A – Observing Sine Wave on Oscilloscope:

Procedure:

(Summarize the main activities that your team did (past tense) in this section).

Results:

Show a copy of Table 5 and Table 6.

Discussions:

1) Answer 8(d).
2) Answer 8(f).
3) Answer 8(h).
4) Answer 8(i).

B - Phase Shift Measurement:

Procedure:

(Summarize the main activities that your team did (past tense) in this section).

Results:

Show the calculations for 8(m).

Discussions:

Answer 8(n).

C – Frequency Response of DMM:

Procedure:

(Summarize the main activities that your team did (past tense) in this section).

Results:

Show a copy of Table 7

Discussions:

1) Answer 8(q).
2) From the above results, which equipment can be used for measurement of the amplitude of a sine wave at high frequency?
3) When is it better to use a DMM?

D – Conclusions:

1) Describe all the parameters of a sine wave that you can observe or measure on an oscilloscope.

2) Are all the Lab objectives met? Explain if some are not.

Appendix:

Attach all Pre-Lab calculations.