

Lab Session No. 11

CALCULATION AND DEMONSTRATION OF RMS, AVERAGE AND PEAK VALUES OF A PERIODIC WAVEFORM USING SIGNAL GENERATOR AND OSCILLOSCOPE

OBJECTIVE

- To study about Root Mean Square (RMS) Value
- Average Value
- Peak Value and Period waveform .

EQUIPMENT REQUIRED

- Function Generator
- Cathode Ray Oscilloscope

THEORY:

In circuit analysis, ac sources are widely used. A dc (direct current) source, current flows only in one direction, but an ac (alternating current) source both voltage and current continually change direction. The rate of change is called the angular velocity, symbol ω and is measured in radians.

One complete cycle of an ac waveform, starts at 0V amplitude, rises to a positive peak and then decreases to a negative trough before ending at 0 volts again. This is shown in Figure 1 below:

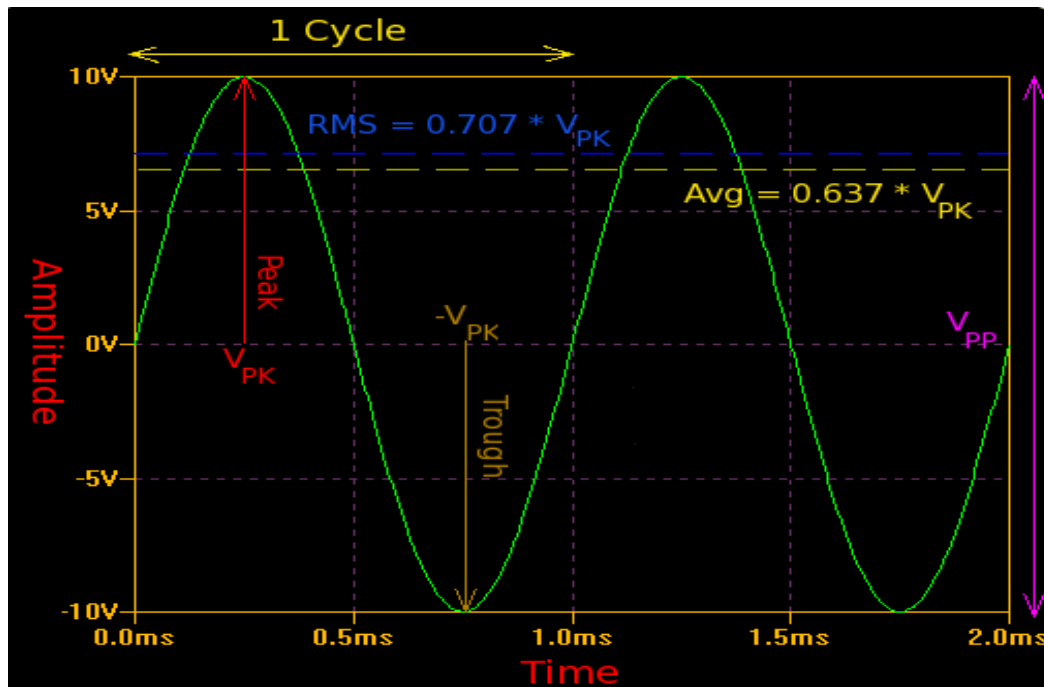
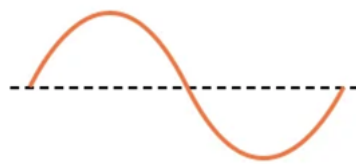


Figure 1(a)



RMS = 0.707 (Peak)
 AVG = 0.637 (Peak)
 P-P = 2 (Peak)

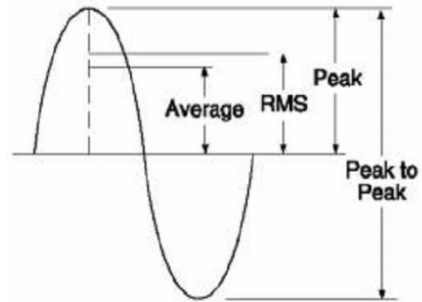


Figure 1(b)

Formula for Average Value

$$V_{avf} = \frac{2V_p}{\pi}$$

$$V_{av} = \frac{1}{\pi} \int_0^{\pi} V_p \sin \theta \, d\theta$$

$$V_{av} = \frac{V_p}{\pi} [-\cos \theta]_0^{\pi}$$

$$V_{av} = \frac{2V_p}{\pi} = 0.637V_p$$

Vavg is approximately 63.7 % of Vp for full wave .

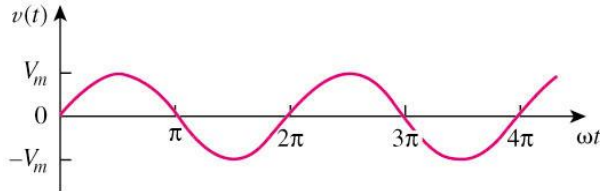
Formula for RMS or effective value

$$V_{RMS} = \frac{V_p}{\sqrt{2}}$$

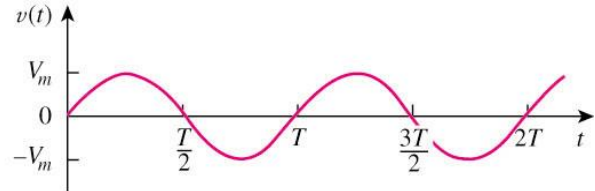
$$V_{RMS} = 0.707 * V_p$$

Periodic waveform

- A sinusoid is a signal that has the form of the sine or cosine function.
- A general expression for the sinusoid,



(a)



(b)

$$v(t) = V_m \sin(\omega t + \phi)$$

where

V_m = the **amplitude** of the sinusoid

ω = the angular frequency in radians/s

Φ = the phase

A **periodic function** is one that satisfies $v(t) = v(t + nT)$, for all t and for all integers n .

$$x(t) = x(t+T)$$
 where $T > 0$, for all t .

Example
 $\sin(t+2\pi) = \sin t$

$x(t) = V_m \sin(\omega t)$
 $x(t+T) = V_m \sin(\omega(t+T))$
 $x(t+T) = V_m \sin(\omega t + \omega \cdot T)$
 $= V_m \sin(\omega t + 2\pi)$

$\omega = 2\pi f$
 $\omega = 2\pi \cdot \frac{1}{T}$
 $T = \frac{2\pi}{\omega}$

So $x(t) = x(t+T)$

\Rightarrow A periodic signal, that repeats
 at self after " T " time interval.

Using Function Generator

Function Generator also called sine generator is used for making a sine wave, square wave and triangular wave. It is used in association with CRO. Signal from Function Generator is fed to the CRO, which analyzes the properties of the signal.



Fig 2. Function Generator

Types Of Signals

Following types of signal can be generated using function generator.

- Sine
- Square
- Triangular

In circuit analysis, we mostly work with sinusoidal (sine) signals.

Oscilloscope

Oscilloscopes are very useful instruments that are used to measure and display a variety of signals. In this lab students will use the oscilloscope to measure voltage, time and frequency and point our Peak value, RMS Value and Average value of voltage using cursor. The front panel of the oscilloscope is shown in figure below.

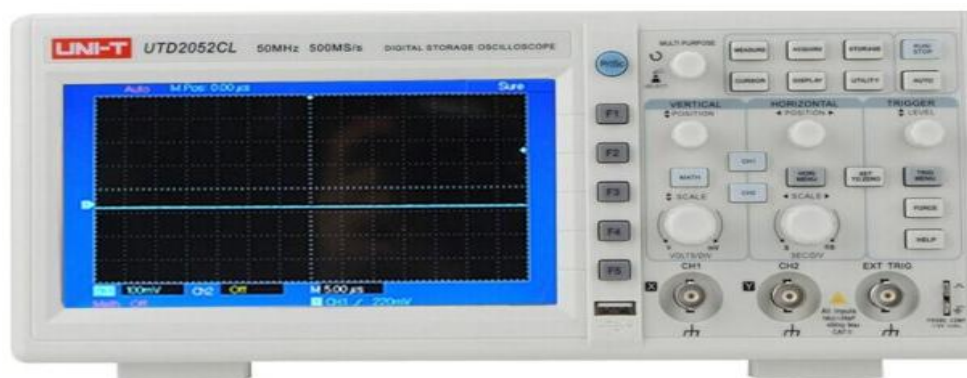


Fig. 3 Oscilloscope

PROCEDURE

- Connect function generator output at the input of CRO at channel 1 or at channel 2.
- Select proper channel i.e. if signal is connected to channel 1 select CH1 and if signal is connected to channel 2 select CH2.
- Adjust Time/Div. knob to get sufficient time period displacement of the wave on the CRO screen. With fine tuning of time/div make the waveform steady on screen.
- Use triggering controls if waveform is not stable.
- Keep volt/div knob such that waveform is visible on the screen without clipping.
- Measure P-P reading along y-axis. This reading multiplied with volt/div gives peak to peak amplitude, RMS and Average value of the AC input wave.
- Measure horizontal division of one complete cycle. This division multiplied by Time/Div gives time period of the input wave.
- Calculate frequency using formula $f = 1/T$.
- Note down your readings in the observation table

OBSERVATIONS

TASK-1:

Calculation of RMS, Average and Peak Value						
Function	Amplitude or Peak Value	RMS Value	Average Value	Time Period	$f = \frac{1}{T}$	Error Value = (Generated - Observed) / Generated *100
	V_{peak}	V_{RMS}	V_{Avg}	Sec (Cxd)	Hz	
Sine						
Square						

Simulation

Pick the SIGNAL GENERATOR object by selecting the Meter icon in ISIS and then selecting the Signal Generator from the Object Selector. Place one on the schematic and wire its outputs into the rest of the circuit and select oscilloscope, place and connect it as per given figure.



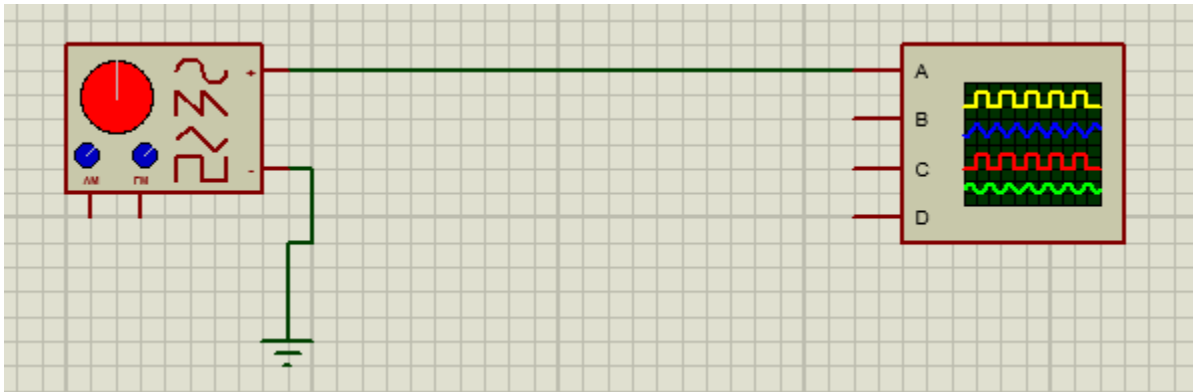


Fig. (Simulation)

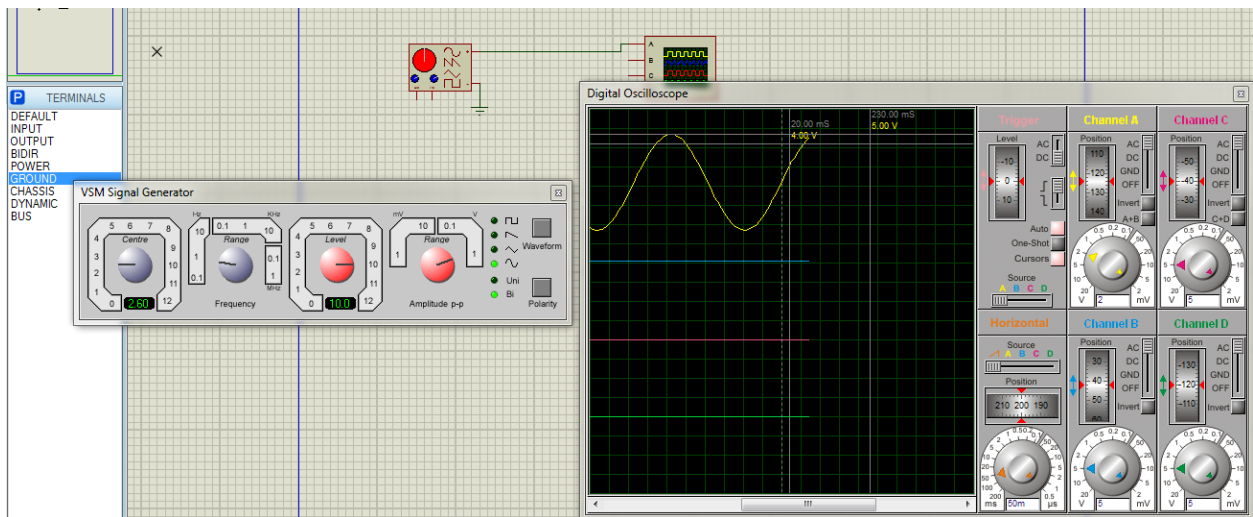


Fig (Simulation Results)

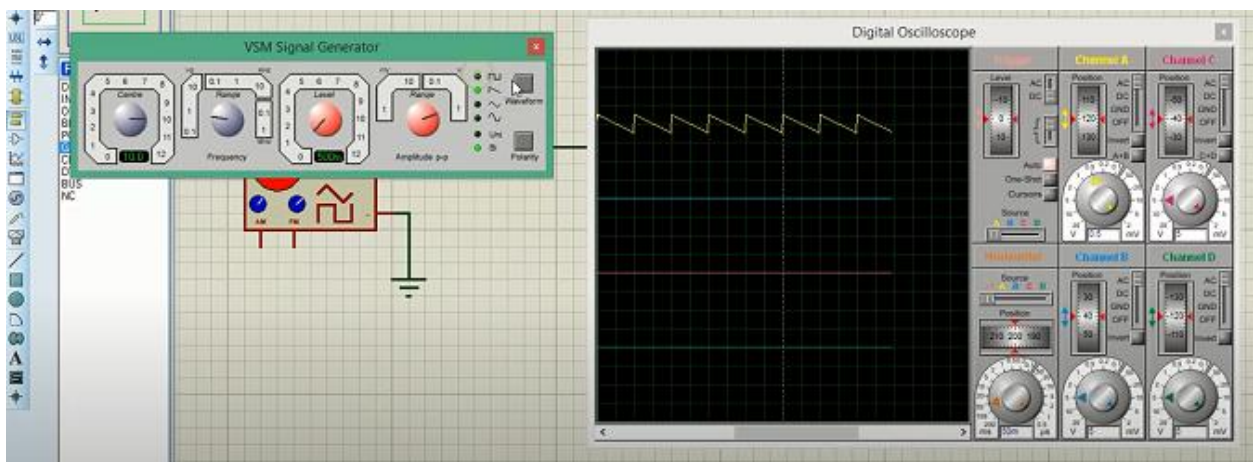


Fig (Simulation Results)