EE LAB

Assignment 1

Done by: Nimal Sreekumar EE23BTECH11044

Praful Kesavadas EE23BTECH11049

Aim

The aim of this assignment is to record the graphs obtained on a Digital Storage Oscilloscope (DSO) obtained by providing different input functions for the X and Y axes. It helps in understanding the working of the device.

Theory

The DSO gets input in the form of analog signals and an Analog-to-digital converter (ADC) converts these signals into digital values as they are easy to store and manipulate. Since these are stored, the DSO is able to display the same waveform even if the signals have stopped changing. Once the signal is stored, the DSO can perform various digital signal processing tasks. This includes operations like filtering, averaging, and measuring various waveform parameters. Digital processing enables advanced features such as zooming, triggering, and complex mathematical analyses.

Procedure

Connect the function generator to the input probes of the DSO. Turn on the DSO. Set the input coupling to DC. Change the mode from Y-t to X-Y mode where channel 1 is for X axis while channel 2 is for Y-axis. You can find the pattern formed in the DSO display. Now vary the input signals to observe different patterns.

Observations

1) Two sine waves of same frequency and phase

Figure 1: Sine waves of same frequency

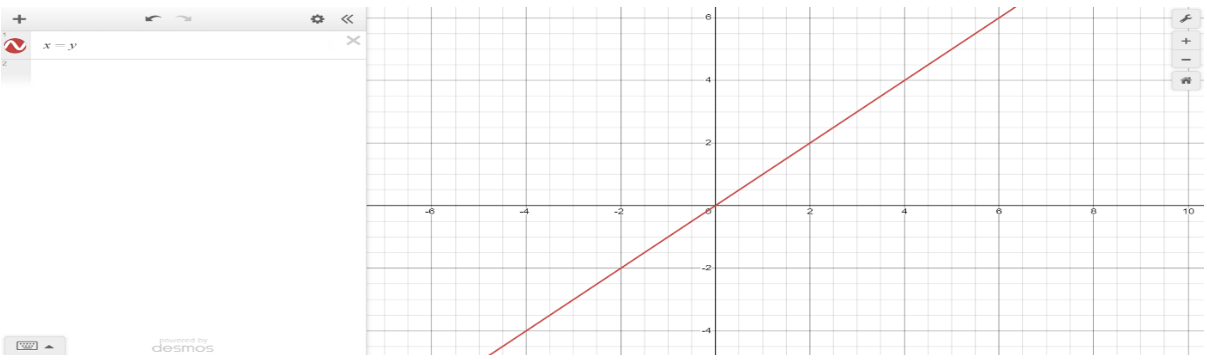


Figure 2 Desmos verification

Reason:

x = y = 7SInwt

2) Two sine waves of different frequency but same phase

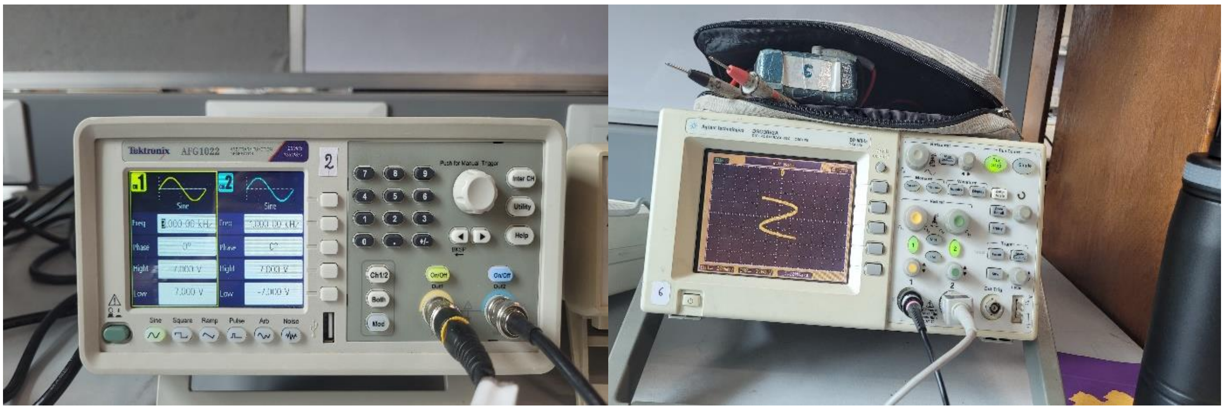


Figure 3

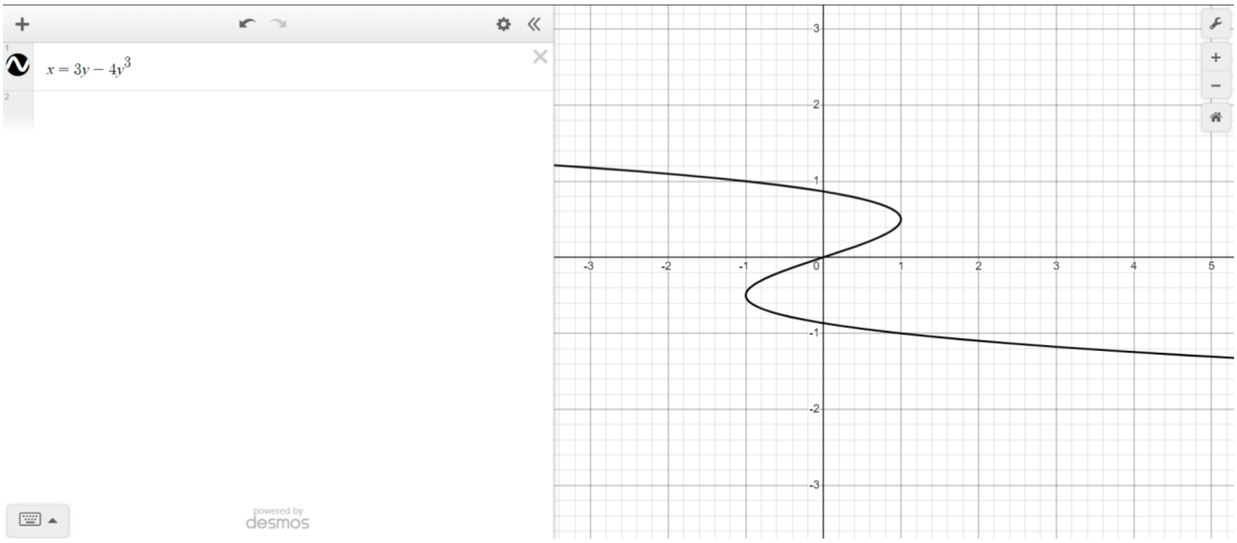


Figure 4: Desmos Verification

Reason:

x = 7 sin(3wt) ; y = 7 sin(wt)

By formula, Sin3wt = 3Sinwt – 4 Sin^3wt

3) Two sine waves of different frequency and 90 degrees phase difference

Figure 5

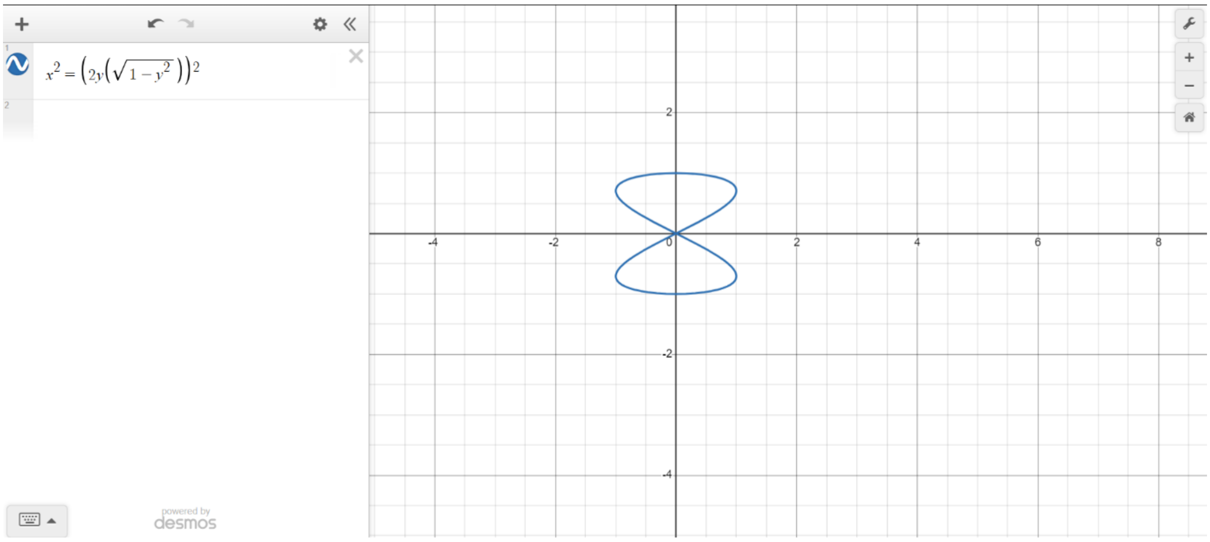


Figure 6 Desmos verification

Reason:

$x = \sin 2\omega t$

$y = \cos \omega t$

$x = 2 \sin \omega t \cos \omega t$

$x = 2y\sqrt{1-y^2}$

4) Two ramp signals of different frequency but same phase

Figure 7 Two ramp signals of different frequencies

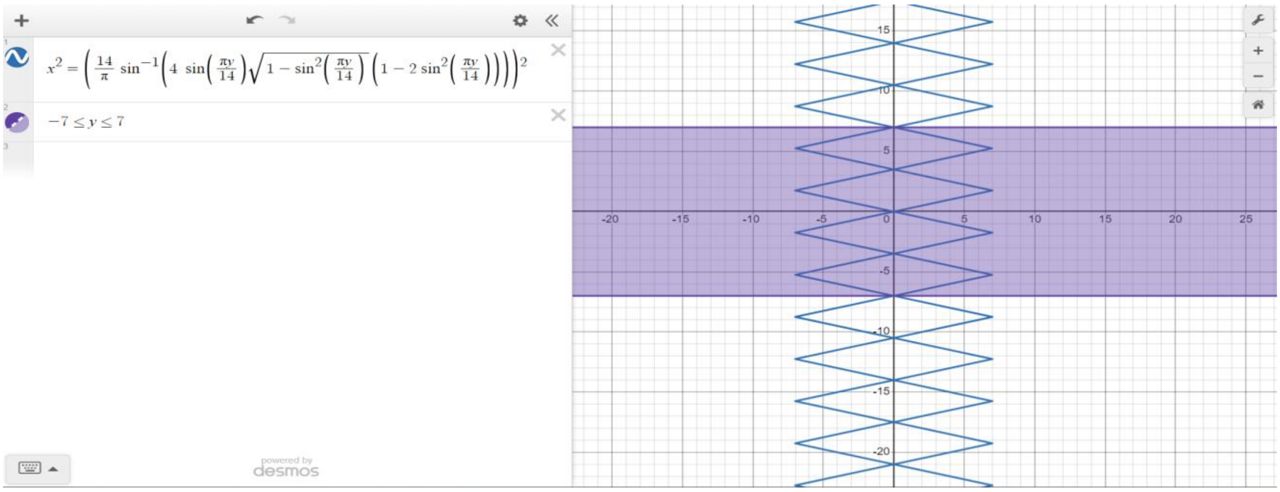


Figure 8 Desmos verification

Reason:

$$x = \frac{14}{\pi}\sin^{-1}(\sin 8\pi t) \qquad y = \frac{14}{\pi}\sin^{-1}(\sin 2\pi t)$$

$$\Downarrow \qquad \Downarrow$$

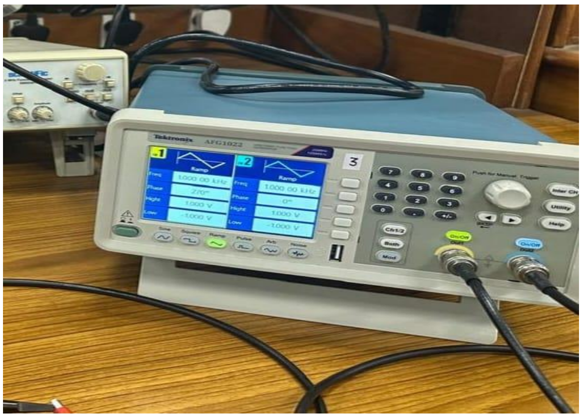
$$\sin 8\pi t = \sin\left(\frac{\pi x}{14}\right) \qquad \sin 2\pi t = \sin\left(\frac{\pi y}{14}\right)$$

$$\sin 8\pi t = 4\sin 2\pi t\sqrt{1-\sin^2 2\pi t}\,(1-2\sin^2 2\pi t)$$

$$\sin\frac{\pi x}{14} = 4\sin\frac{\pi y}{14}\sqrt{1-\sin^2\frac{\pi y}{14}}\left(1-2\sin^2\frac{\pi y}{14}\right)$$

$$x = \frac{14}{\pi}\sin^{-1}\left(4\sin\frac{\pi y}{14}\sqrt{1-\sin^2\frac{\pi y}{14}}\left(1-2\sin^2\frac{\pi y}{14}\right)\right)$$

5) Two ramp signals of same frequency but 90 degrees out of phase



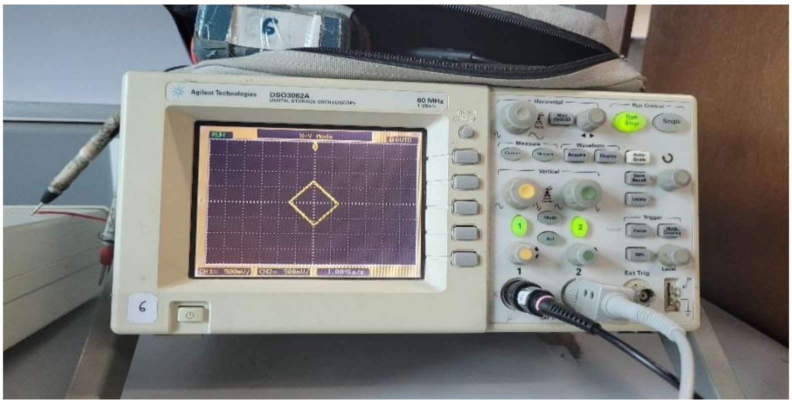


Figure 9 Two ramp signals of same frequency but out of phase by 90 degrees

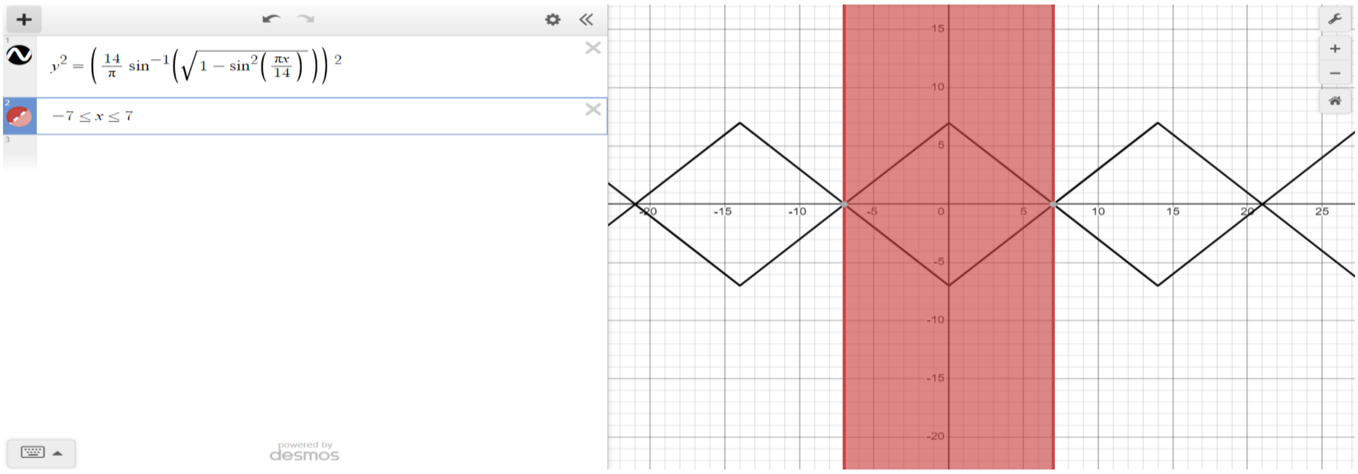


Figure 10 Desmos Verification

Reason:

$$x = \frac{14}{\pi}\sin^{-1}(\sin 2\pi t) \qquad y = \frac{14}{\pi}\sin^{-1}\left(\sin\left(2\pi t + \frac{3\pi}{2}\right)\right)$$

$$= \frac{14}{\pi}\sin^{-1}(-\cos 2\pi t)$$

$$= -\frac{14}{\pi}\sin^{-1}(\cos 2\pi t)$$

$$\sin 2\pi t = \sin\left(\frac{\pi x}{14}\right) \qquad \cos 2\pi t = -\sin\frac{\pi y}{14}$$

$$\Downarrow$$

$$\sqrt{1-\sin^2 2\pi t} = -\sin\frac{\pi y}{14}$$

$$y = -\frac{14}{\pi}\sin^{-1}\left(\sqrt{1-\sin^2 2\pi t}\right)$$

$$y = -\frac{14}{\pi}\sin^{-1}\left(\sqrt{1-\sin^2\frac{\pi x}{14}}\right)$$

$$y^2 = \left(\frac{14}{\pi}\sin^{-1}\sqrt{1-\sin^2\frac{\pi x}{14}}\right)^2$$

6) Ramp and sine waves of same frequency and phase

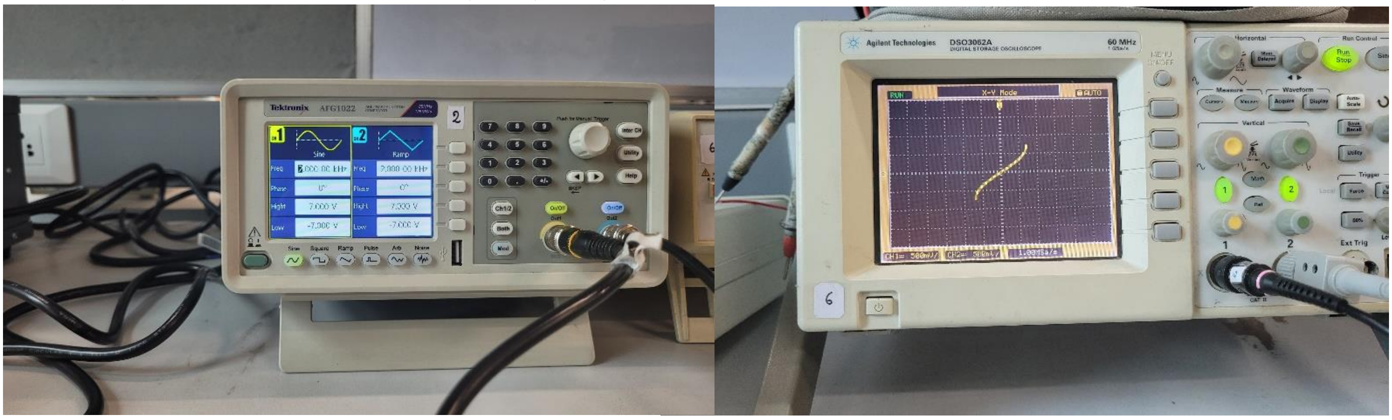


Figure 11 Ramp and sine

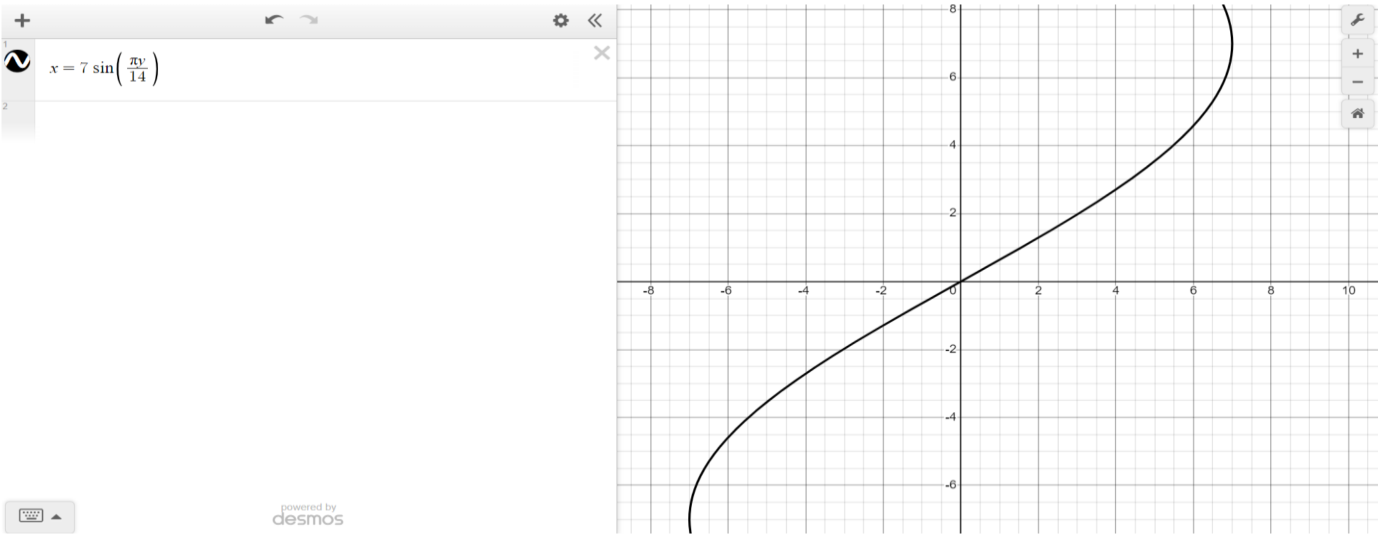


Figure 12 Desmos Verification

Reason:

$$x = 7\sin\omega t$$

$$y = \frac{14}{\pi}\sin^{-1}(\sin\omega t)$$

$$\sin\frac{\pi y}{14} = \frac{x}{7}$$

7) Two ramp signals with same frequency and phase but different amplitudes

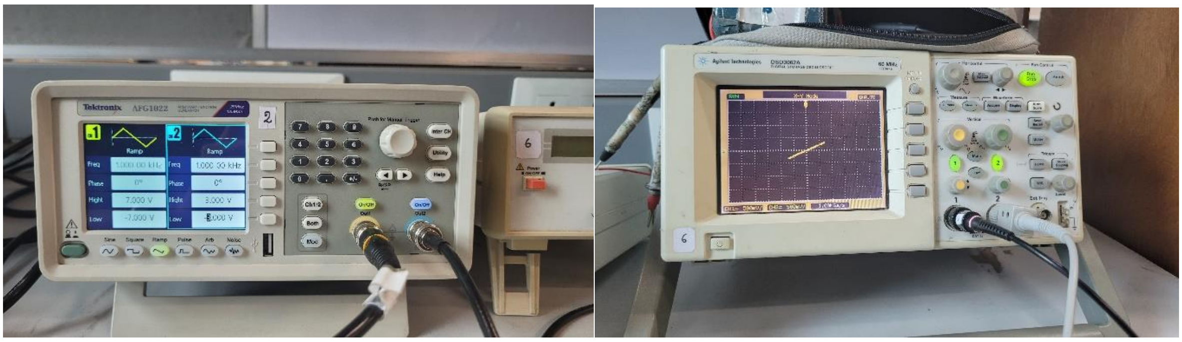


Figure 13 Ramp with different amplitudes

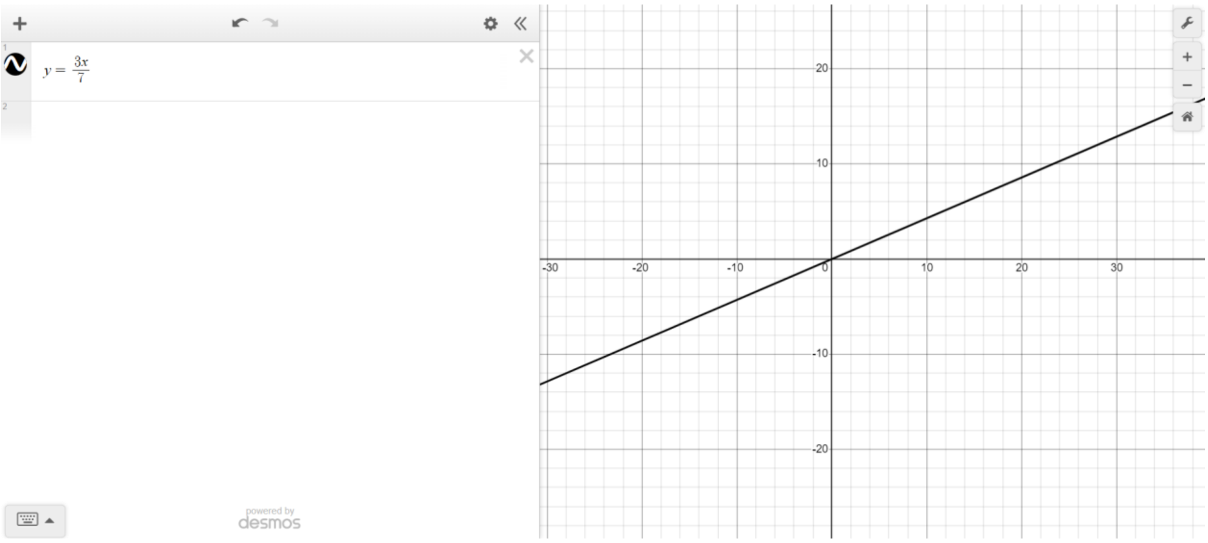


Figure 14 Desmos Verification

Reason:

$$x = \frac{14}{\pi} \sin^{-1}(\sin \omega t) \qquad y = \frac{6}{\pi} \sin^{-1}(\sin(\omega t))$$

$$\frac{x}{14} = \frac{y}{6}$$

$$y = \frac{3x}{7}$$

8) Two sine waves with same frequency but 90 degrees out of phase

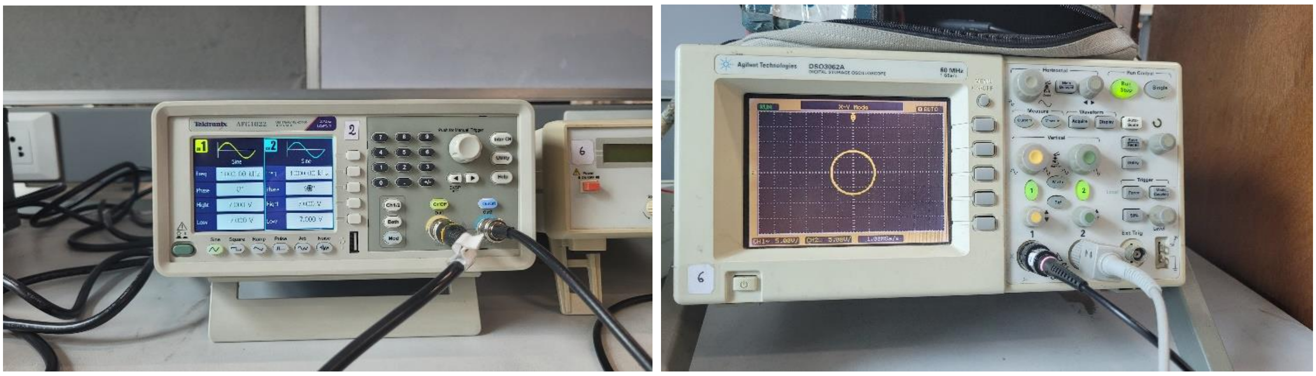


Figure 15

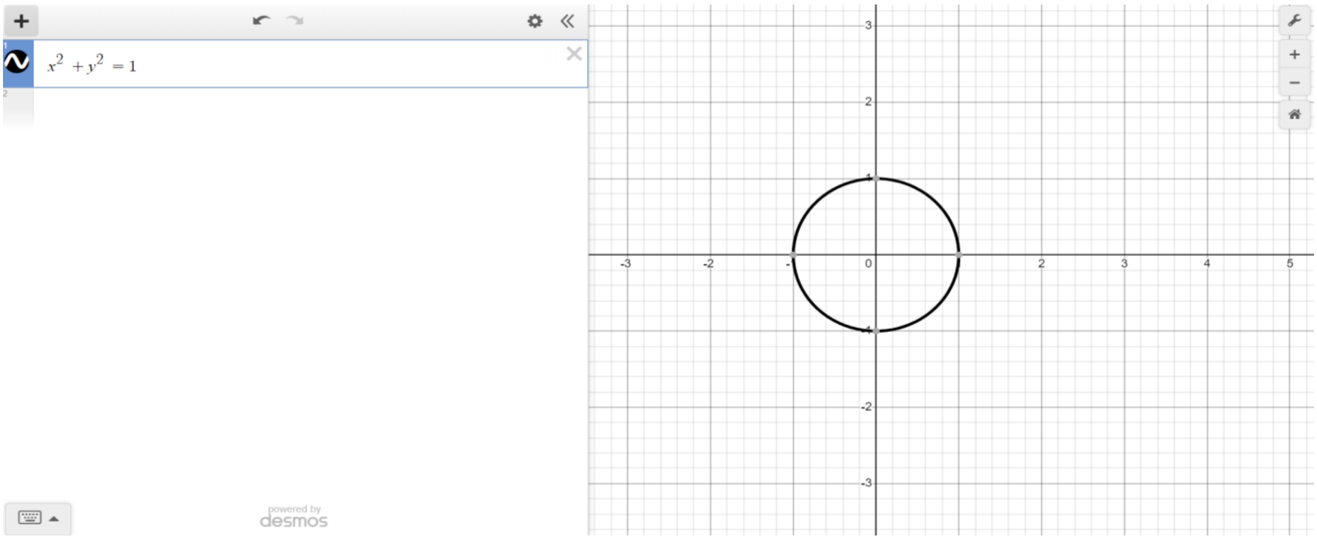


Figure 16: Desmos Verification

Reason:

x= Sinwt ; y= Coswt ;

We know that

$\text{Sin}^2\text{wt} + \text{Cos}^2\text{wt} = 1$ i.e. $x^2 + y^2 = 1$

Result

We took 8 different signal pairs and verified the pattern formed using desmos graphing calculator.

Assignment 2

Aim

To capture a one-time event using a CRO with an example

Theory

- An oscilloscope’s trigger function synchronizes the horizontal sweep at the correct point of the signal. This is essential for clear signal characterization. Trigger controls allow you to stabilize repetitive waveforms and capture single-shot waveforms.
- The trigger makes repetitive waveforms appear static on the oscilloscope display by repeatedly displaying the same portion of the input signal
- Digital oscilloscopes can provide pre-trigger viewing because they constantly process the input signal, whether or not a trigger has been received. A steady stream of data flows through the oscilloscope; the trigger merely tells the oscilloscope to save the present data in memory.

Procedure

Connect the signal generator to the oscilloscope and power them on. Adjust the size of waveform for accurate viewing. Set the signal generator in burst mode such that it sends a burst of signals at one point of time, the number of cycles can be adjusted using the controls in the generator. Run the oscilloscope and you will find that the burst of signals has been recorded by the oscilloscope.

Observation

Figure: Capturing burst of sine waves

Result

A one-time event was captured by the DSO, with the exact number of cycles required.