Lab Report: Experiment 1

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Experiment:
Plotting Lissajous Figures
and Capturing One-Time Events
on an Oscilloscope

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Objective

1. To observe and analyze at least 6 Lissajous figures using an oscilloscope and justify their patterns with Python codes.
2. To demonstrate the method to capture a one-time event.

Equipment Used

- Oscilloscope
- Function generator
- Oscilloscope probes and cables

Theory

Lissajous Figures

Say we are given two waveforms defined by,

$$x(t) = f_x(t, A_x, \omega_x, \phi_x)$$
$$y(t) = f_y(t, A_y, \omega_y, \phi_y)$$

Where A, ω, ϕ represent Amplitude, Angular Frequency, Initial Phase respectively. A Lissajous figure is the graph obtained by plotting $x(t)$ against $y(t)$. For sinusoidal waveforms,

$$x(t) = A\sin(\omega t + \phi)$$

and for ramp waveforms, one way of representing them is,

$$x(t) = (\frac{2A}{\pi}\cos^{-1} cos(\omega t + \phi)) - A$$

Ramp waveforms may also be defined as a piece-wise function, but this is what we have used in our python code to verify. To verify results, we can obtain the points in $x(t), y(t)$ and plot them against each other.

Procedure

Plotting of Lissajous Figures

1. Connect the two input channels of the function generator to the two reciever channels of the oscilloscope.

2. For each channel, connect the positive end of the cable from the function generator to the positive end of the probe and the other (ground) end to the ground of the probe

3. Set the function generator to produce sinusoidal (or ramp) waveforms on both channels of varying phase, amplitude, frequency.

4. Use the phase alignment feature of the function generator to ensure that both waveforms start at the same time.

5. Record and analyze the patterns observed on the oscilloscope.

6. Repeat the process for at least six different sets of waveforms in which the amplitude, starting-phase, frequency, wave-type (ramp or sinusoidal) parameters are varied

Capturing One-Time Events

1. In the function generator, select a square wave (alternatively, a ramp or sine function may also be used) as the waveform.

2. Press the *MOD* button and choose the *BURST* option. Set the trigger to manual.

3. Select the type of cycle as *N-CYCLES*.

4. This configuration enables the generation of a square wave with a predefined number of cycles when the trigger button is pressed on the function generator.

5. Connect the function generator to the oscilloscope.

6. On the oscilloscope, press the *SINGLE* button. This ensures that the next event captured by the oscilloscope is displayed and then the display pauses automatically.

7. Trigger the burst mode manually on the function generator to generate the single pulse or event.

8. Observe and record the captured waveform on the oscilloscope.

Results and Verification

We have written the code in python to plot the same figures to verify if the figures obtained on the oscilloscope are correct or not.

Lissajous Figures

1. $x(t) = 13\sin(2000\pi\omega t + \frac{\pi}{3})$, $y(t) = 4\sin(10000\pi\omega t + \frac{5\pi}{9})$

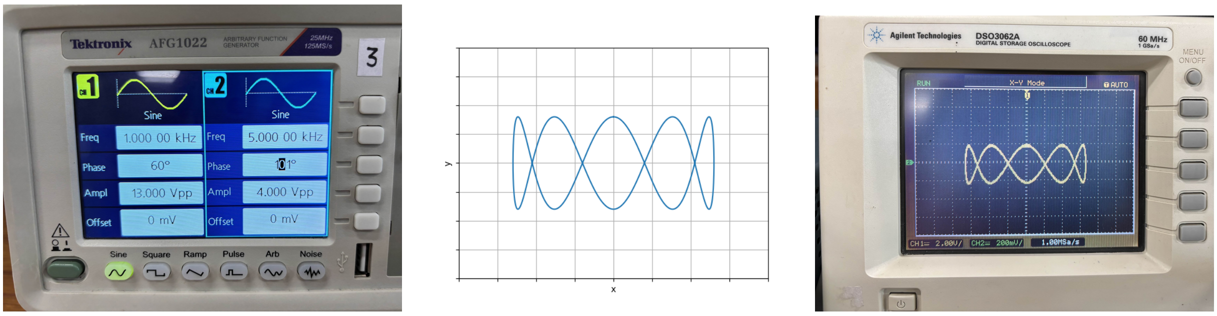

Figure 1: Lissajous Figure 1

2. $x(t) = 7\sin(2000\pi\omega t + \frac{\pi}{2})$, $y(t) = 7\sin(1000\pi\omega t)$

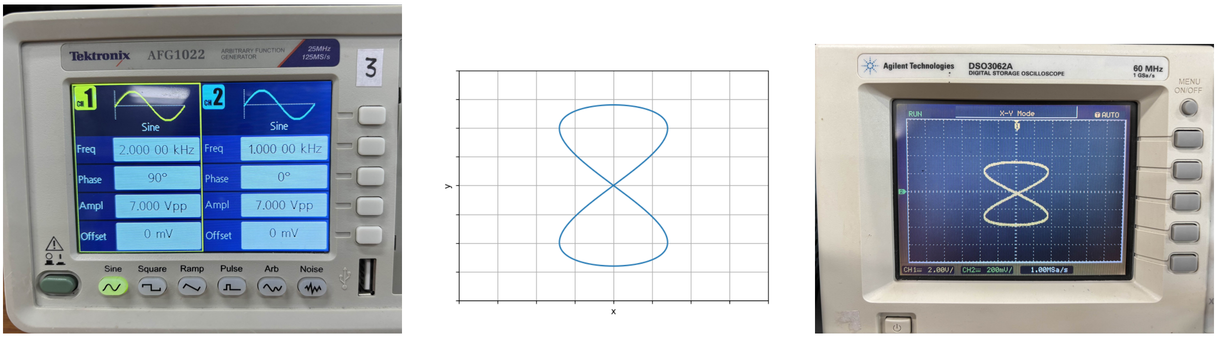

Figure 2: Lissajous Figure 2

3. $x(t) = 7\sin(1000\pi\omega t + \frac{\pi}{3})$, $y(t) = 7\sin(1000\pi\omega t)$

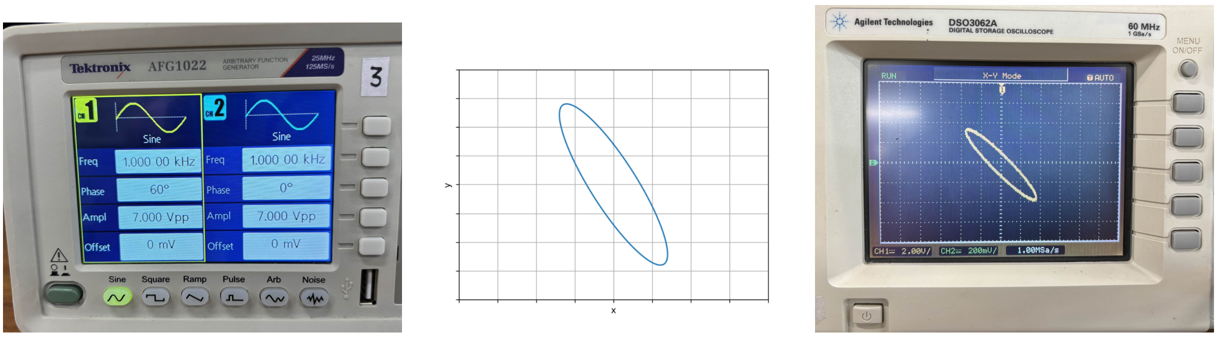

Figure 3: Lissajous Figure 3

4. $x(t) = 13\sin(6000\pi\omega t + \frac{\pi}{2})$, $y(t) = 5\sin(32000\pi\omega t + \frac{31\pi}{36})$

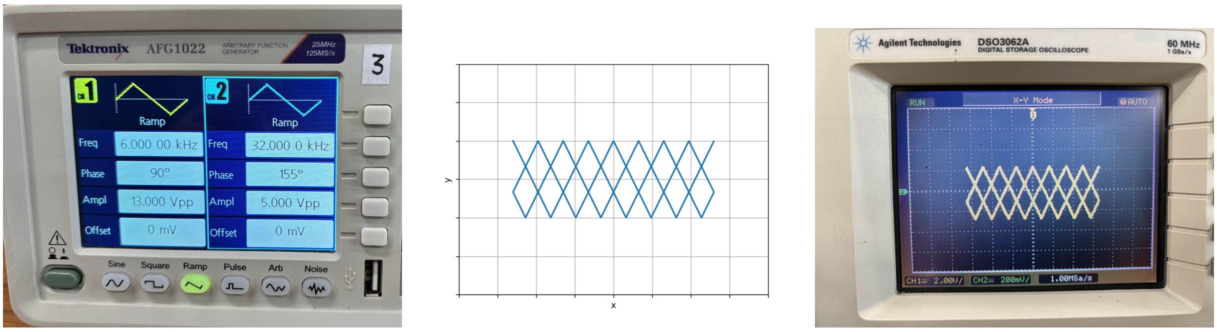

Figure 4: Lissajous Figure 4

5. $x(t) = 13\sin(6000\pi\omega t + \frac{\pi}{2})$, $y(t) = 5\sin(32000\pi\omega t + \frac{11\pi}{36})$

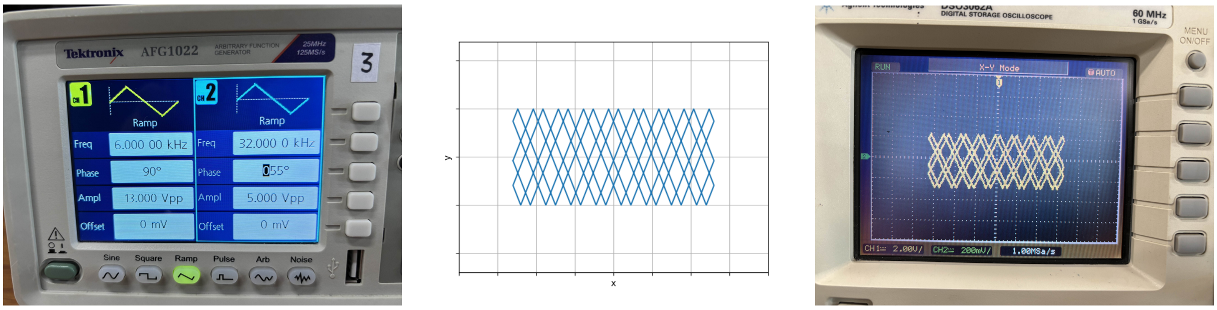

Figure 5: Lissajous Figure 5

6. $x(t) = 13\sin(1000\pi\omega t + \frac{\pi}{3})$, $y(t) = 4\sin(2000\pi\omega t + \frac{\pi}{12})$

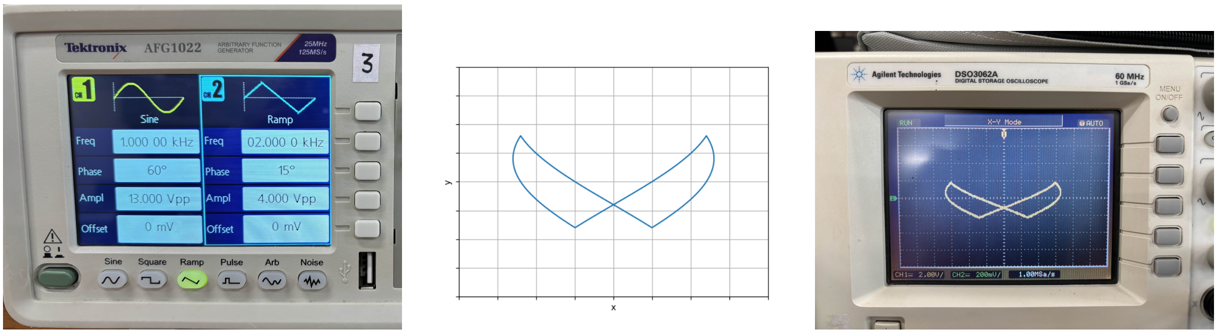

Figure 6: Lissajous Figure 6

7. $x(t) = 13\sin(2000\pi\omega t + \frac{\pi}{3})$, $y(t) = 4\sin(12000\pi\omega t + \frac{\pi}{12})$

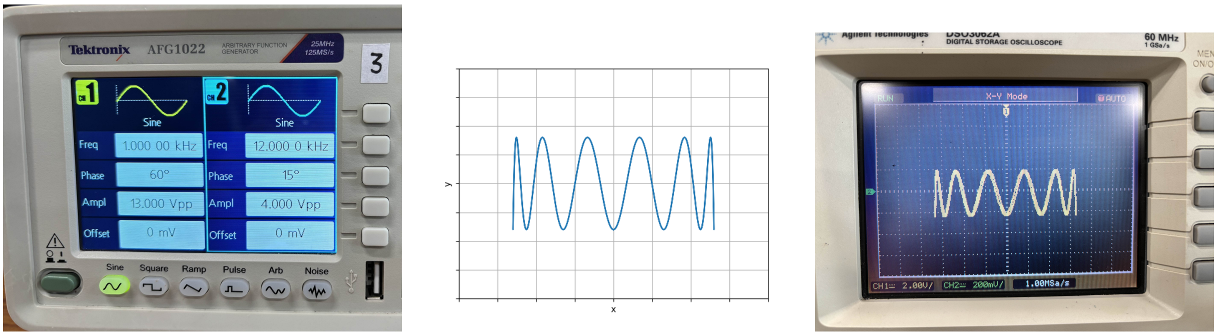

Figure 7: Lissajous Figure 7

We see that all the python and oscilloscope plots match. Hence, the plots are accurate
Python code verification of Lissajous figures:
`https://github.com/ArjunPavanje/EE1200/tree/main/Experiment_1/codes`

One-Time Event Capture

The `Single` mode on the oscilloscope ensures that the display is frozen after capturing the first trigger event. This is useful for observing transient signals or rare events. By using burst mode on the function generator, a precise number of cycles or a single waveform is generated and can be accurately captured.
In this case, we have used a square wave input of amplitude 5 Vpp and have set the number of cycles to 5.

Below is the plot for the one time event which was captured

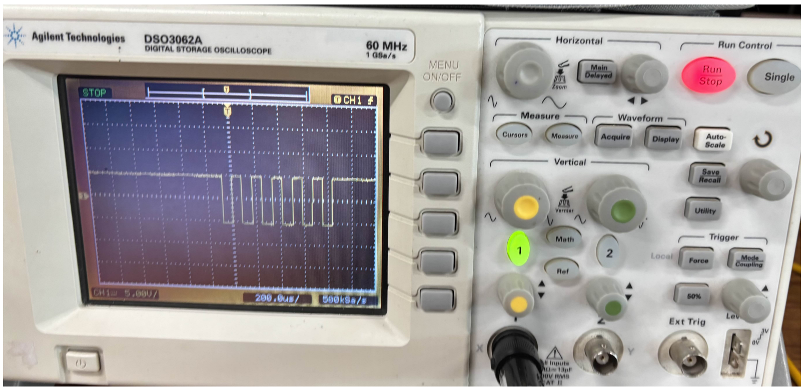

Figure 8: Capturing a one time event

Conclusion

The experiment successfully demonstrated the generation and analysis of Lissajous figures, highlighting their dependence on frequency ratio and phase difference. The procedure to capture one-time events on a oscilloscope was also explored and verified using burst mode with manual triggering.