EC 3305: SIGNALS AND SYSTEMS

LABORATORY 01

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GROUP : CE 08

DATE : 09 /12/2024

TABLE 01: SUMMATIVE LABORATORY FORM

Semester	03
Module Code	EC 3305
Module Name	Signals and Systems
Lab Number	01
Lab Name	Continuous-time Signal Analysis
Lab conduction date	2024.12.09
Report Submission date	2024.12.23

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 OBSERVATIONS

1.1 PART 01: OBSERVE THE WAVEFORM IN THE TIME DOMAIN AND IN FREQUENCY DOMAIN

1.1.1 SIGNALS IN TIME DOMAIN AND FREQUENCY DOMAIN

TABLE 1: PROPERTIES OF SINUSOIDAL WAVEFORM

PROPERTY	VALUE
Amplitude	5.0V
Frequency	2 kHz
Period	499.2μs

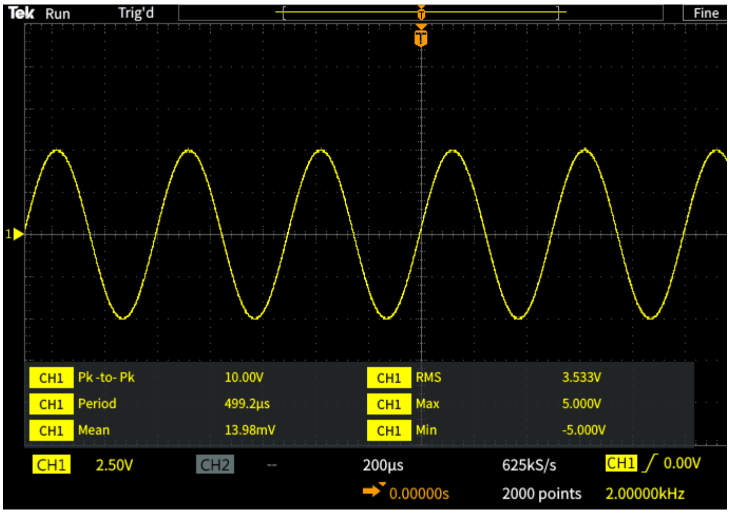


FIGURE 02:SINUSOIDAL WAVEFORM WITH 2kHz FREQUENCY AND 5V AMPLITUDE FOR CHANNEL 1

TABLE 2: PROPERTIES OF SINUSOIDAL WAVEFORM IN FREQUENCY DOMAIN

PROPRETY	VALUE
Amplitude	5V
Frequency	1.997kHz
Period	500.8µs

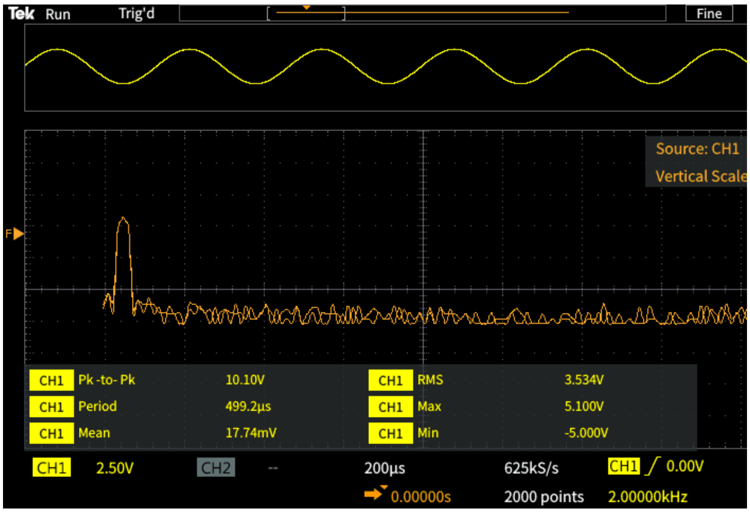


FIGURE 02: WAVEFORM OF FIGURE01 IS IN THE FREQUENCY DOMAIN

1.1.2 ADDER CIRCUIT

TABLE 3: PROPERTIES OF THE INPUT AND OUTPUT WAVEFORMS OF THE ADDER CIRCUIT

SIGNAL	PROPERTY	VALUE
Input Signal	period	500µs
	Frequency	2 kHz
Output Signal	period	499.2µs
	Frequency	2Hz

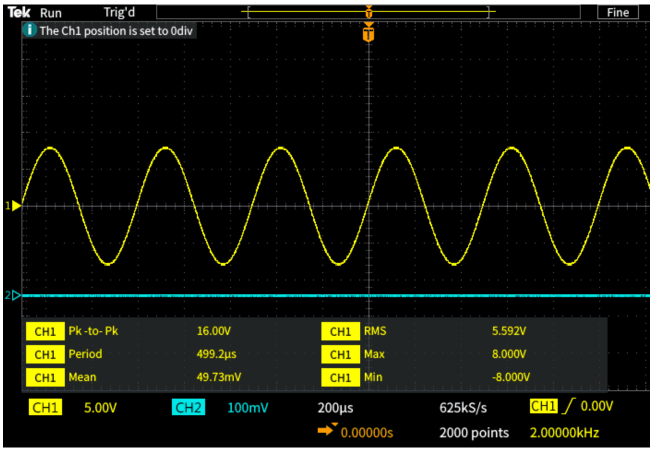


FIGURE 03 : OUTPUT WAVEFORM OF ADDER CIRCUIT IN TIME DOMAIN

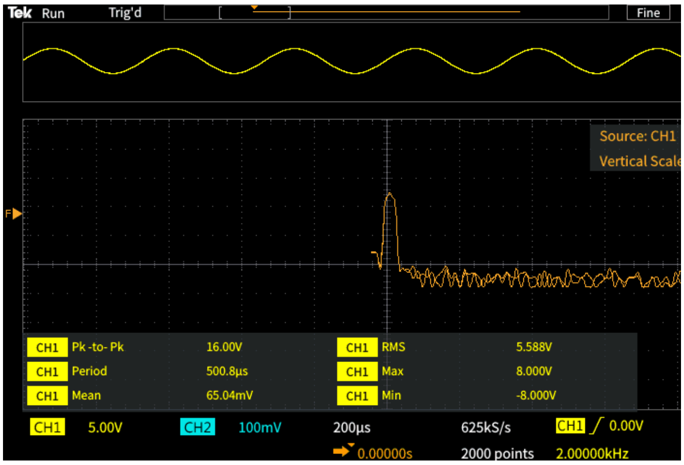


FIGURE 04 : OUTPUT WAVEFORM OF ADDER CIRCUIT IN FREQUENCY DOMAIN

1.1.3 SQUARE WAVEFORM

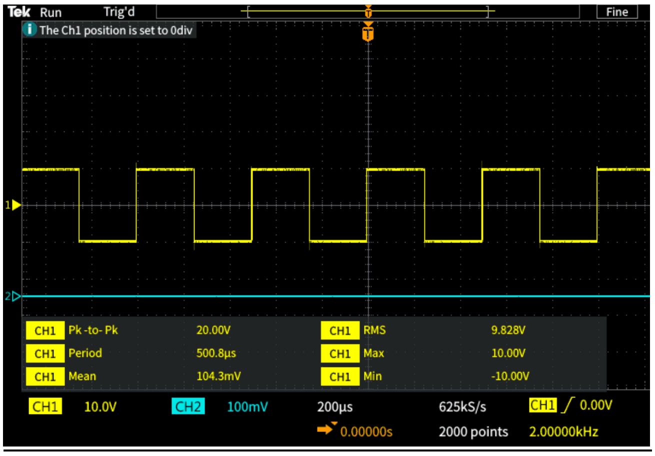


FIGURE 05 : SQUARE WAVEFORM WHICH IS GENERATED BY SIGNAL GENERATOR

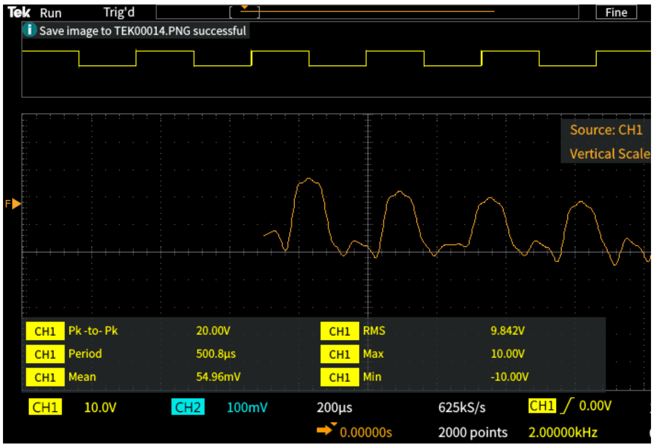


FIGURE 06: WAVEFORM IS IN TIME AND FREQUENCY DOMAINS WHEN DUTY CYCLE IS +4.167

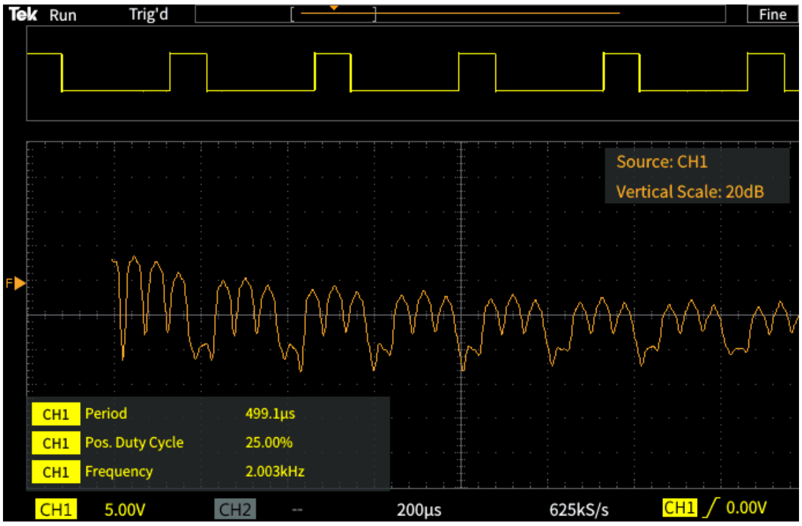


FIGURE 07: WAVEFORM IS IN TIME AND FREQUENCY DOMAINS WHEN DUTY CYCLE IS +25%

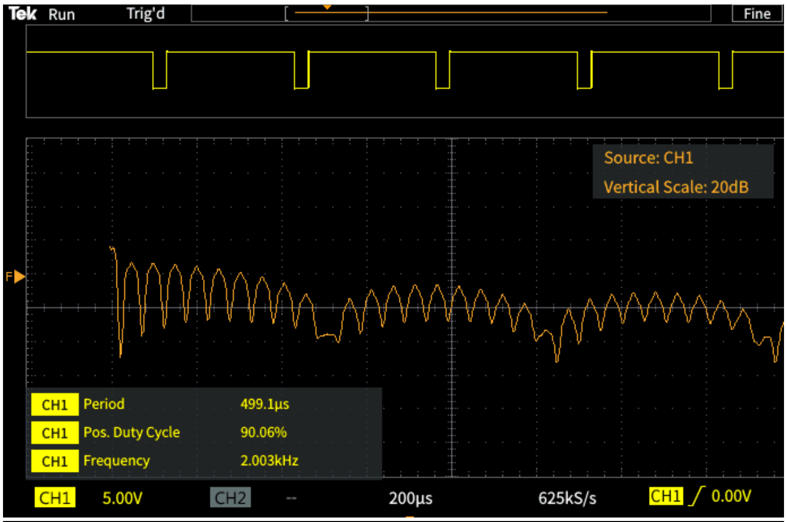


FIGURE 08: WAVEFORM IS IN TIME AND FREQUENCY DOMAINS WHEN DUTY CYCLE IS +90.06%

1.2 PART 02: OBSERVE THE LISSAJOUS PATTERN USING OSCILLOSCOPE WHILE COMPARING FREQUENCY AND THE PHASE SHIFT DIFFERENCE OF THE TWO WAVEFORMS

TABLE 4: PROPERTIES OF THE INPUT SINOSOIDAL WAVEFORMS OF THE ADDER CIRCUIT

PROPRETY	INPUT 1	INPUT 2
Amplitude	5V	5V
Frequency	2 kHz	4 kHz
Phase Angle	0^0	180^0

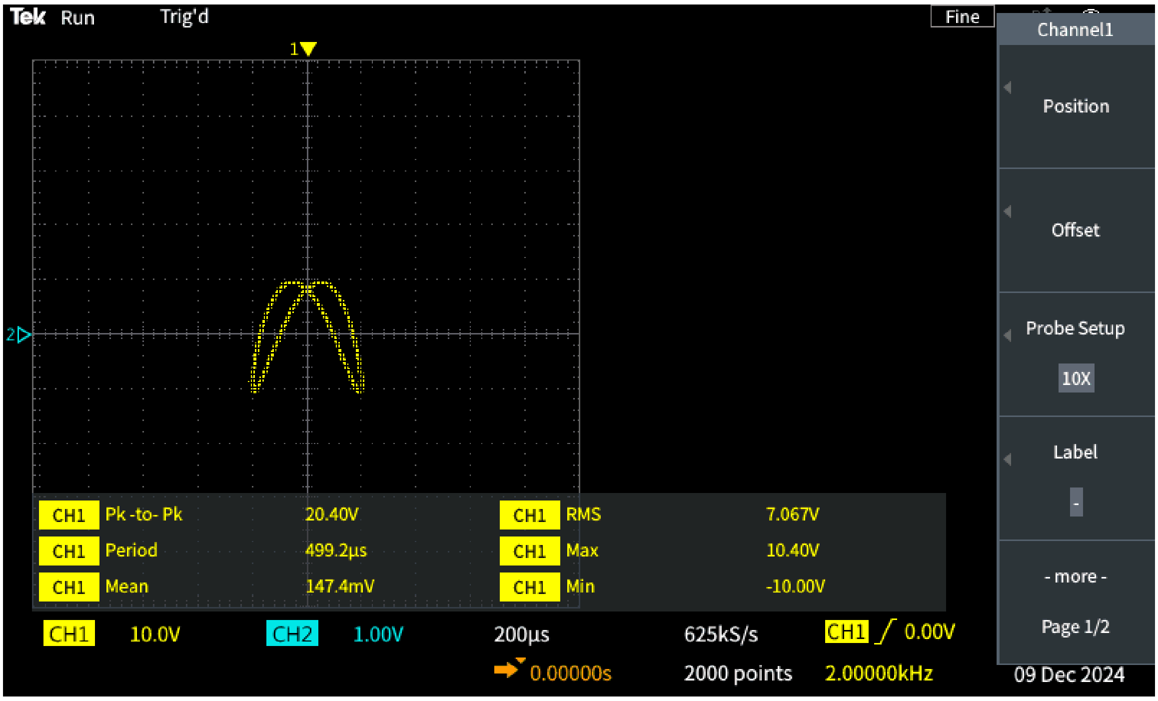


FIGURE 9: THE OUTPUT LISSAJUOS PATTERN WHICH IS RELATED TO WAVEFORMS IN TABLE 4

TABLE 5: PROPERTIES OF THE INPUT SINOSOIDAL WAVEFORMS OF THE ADDER CIRCUIT

PROPRETY	INPUT 1	INPUT 2
Amplitude	5V	5V
Frequency	3 kHz	2 kHz
Phase Angle	0^0	60^0

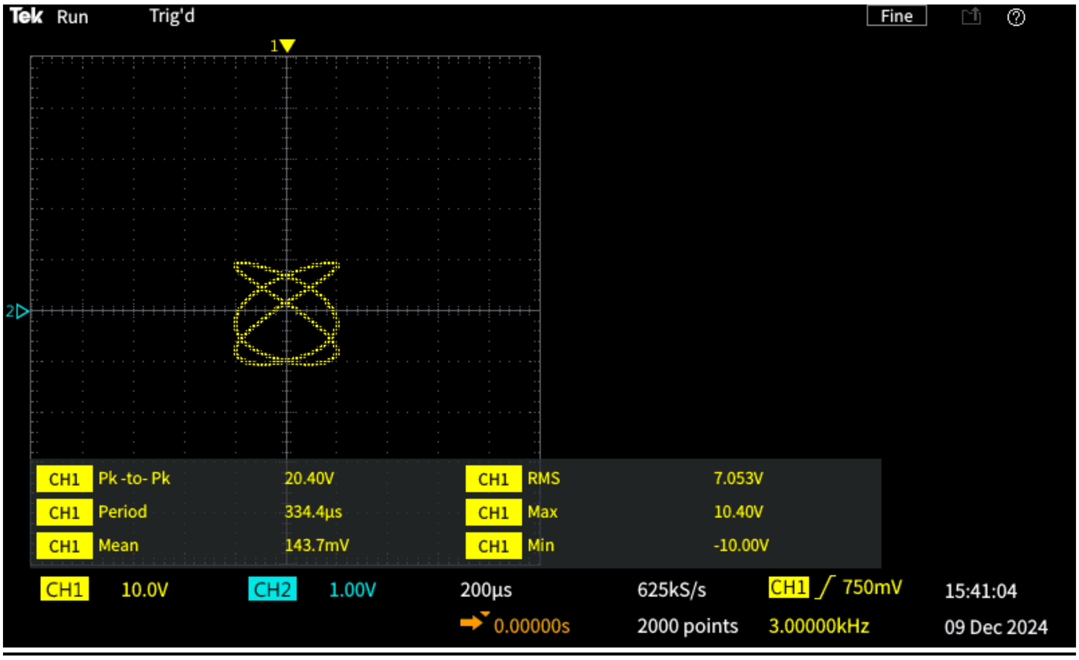


FIGURE 10: THE OUTPUT LISSAJUOS PATTERN WHICH IS RELATED TO WAVEFORMS IN TABLE 5

TABLE 6: PROPERTIES OF THE INPUT SINOSOIDAL WAVEFORMS OF THE ADDER CIRCUIT

PROPRETY	INPUT 1	INPUT 2
Amplitude	5V	5V
Frequency	3 kHz	2 kHz
Phase Angle	0^0	90^0

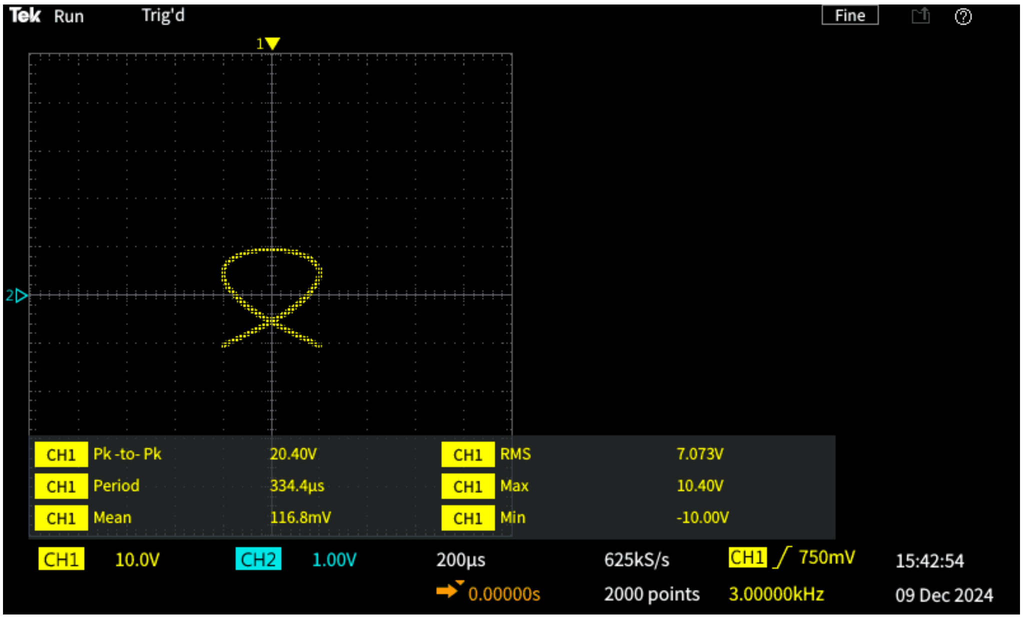


FIGURE 11: THE OUTPUT LISSAJUOS PATTERN WHICH IS RELATED TO WAVEFORMS IN TABLE 6

TABLE 7: PROPERTIES OF THE INPUT SINOSOIDAL WAVEFORMS OF THE ADDER CIRCUIT

PROPRETY	INPUT 1	INPUT 2
Amplitude	5V	5V
Frequency	2 kHz	4 kHz
Phase Angle	0^0	60^0

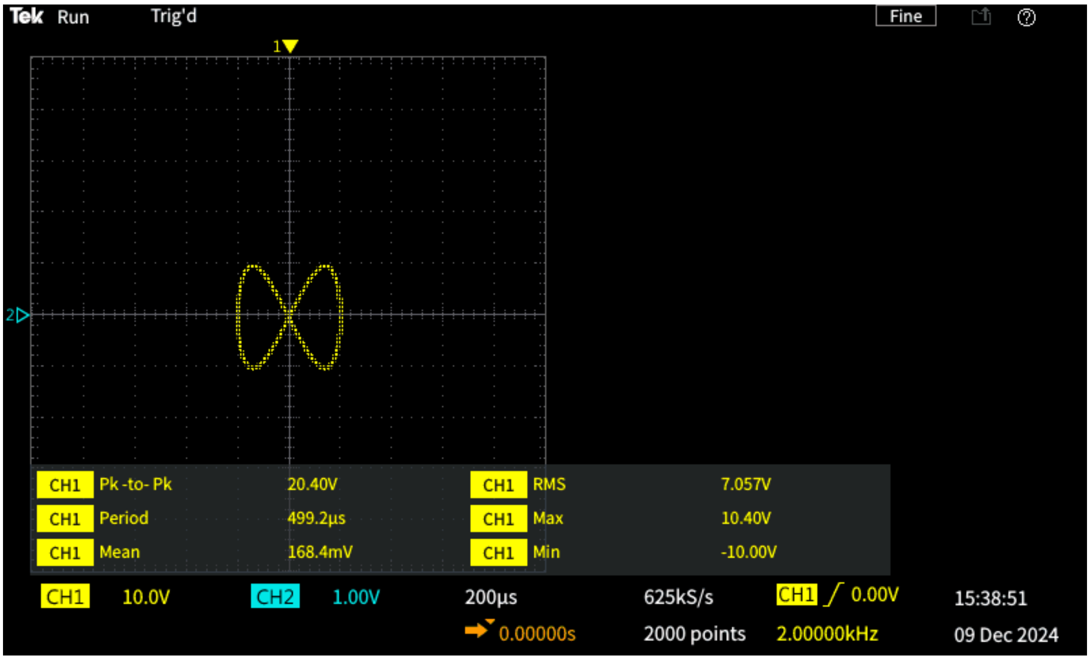


FIGURE 12: THE OUTPUT LISSAJUOS PATTERN WHICH IS RELATED TO WAVEFORMS IN TABLE 7

1.3 PART 03: COMPARISON OF TWO WAVEFORMS USING OSCILLOSCOPE

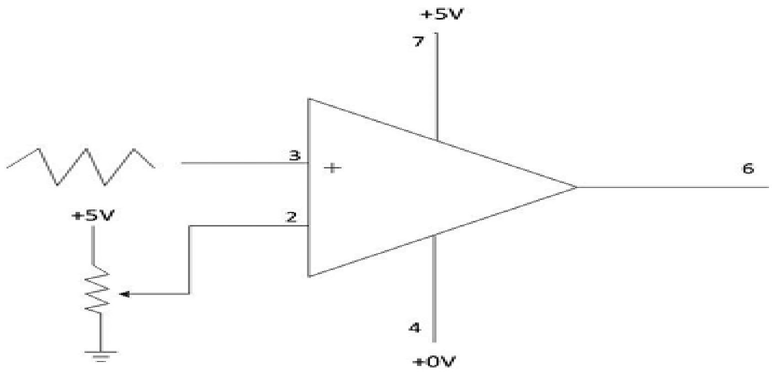


FIGURE 13: IC741 CONNECTION DIAGRAM

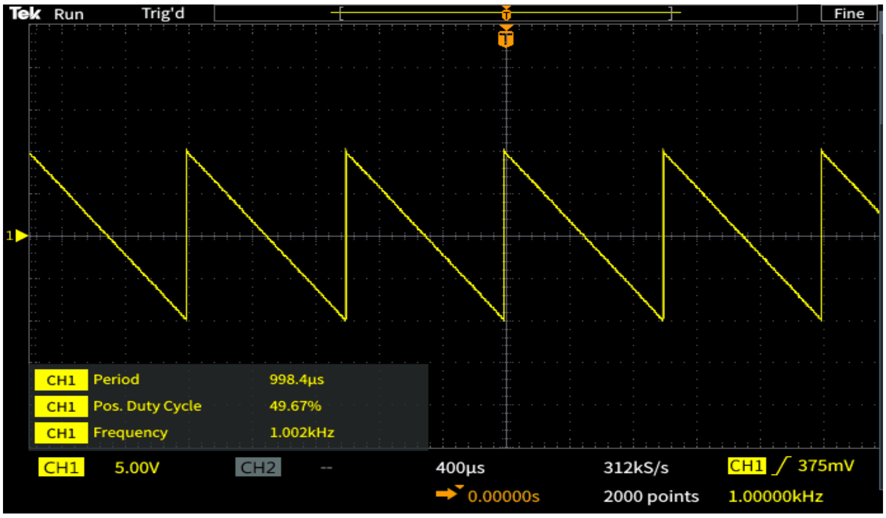


FIGURE14: INPUT WAVEFORM

TABLE 8: PROPERTIES OF INPUT SAW TOOTH WAVEFORM

PROPERTY	VALUE
Amplitude	5 V
Frequency	1 kHz

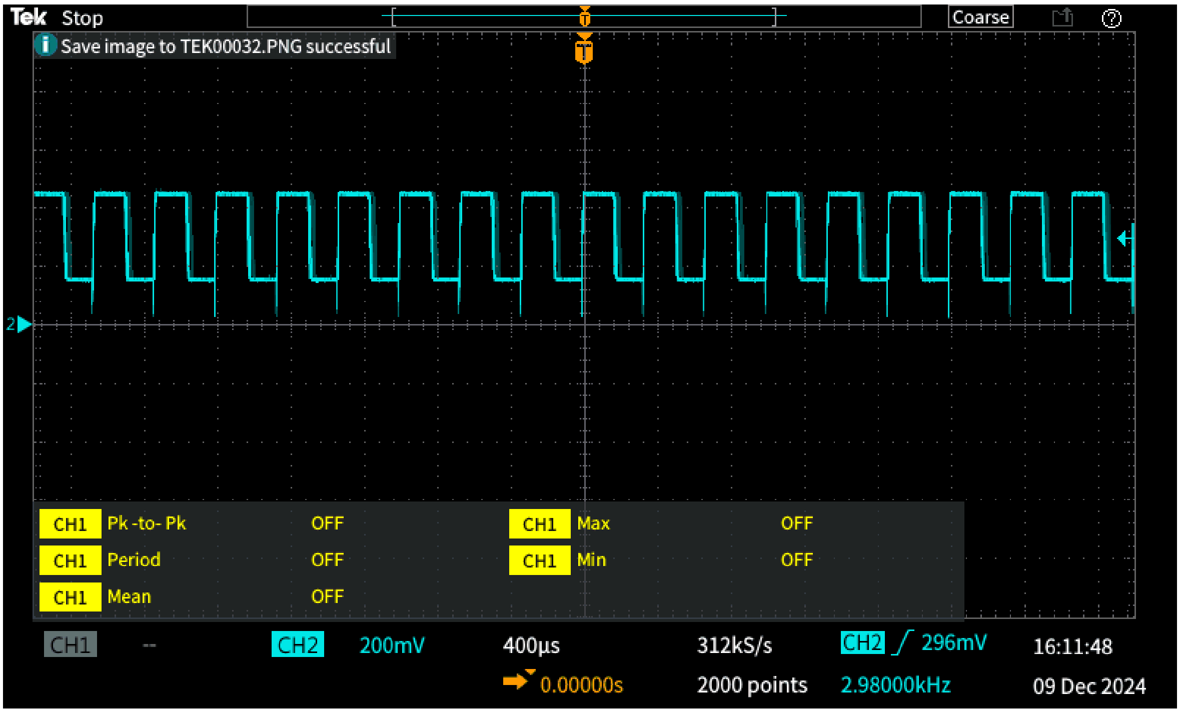


FIGURE 15: OUTPUT WAVEFORM RELATED TO INPUT WAVEFORM

2 CALCULATIONS

2.1 SPECIMAN CALCULATIONS

By drawing horizontal and vertical lines through the center of the pattern the frequency ratio can be determined.

From Lissajous pattern of figure 9 in part 2;

$$\text{Frequency ratio} = \frac{fy}{fx}$$

$$= \frac{number\ of\ horizontal\ crossings}{number\ of\ vertical\ crossings}$$

$$= \frac{4}{2}$$

$$= \underline{\underline{2}}$$

3 DISCUSSION

1. The phase angle and magnitude relationships of two sinusoids are crucial in determining the shape of Lissajous patterns. The phase angle indicates the relative timing of two sinusoidal signals. Specific values of the phase angle yield characteristic shapes in Lissajous figures.

   0° Phase Difference: When two sinusoids are in phase (0°), they create a straight line at a 45° angle to the axes. This implies that both waves reach their maximum and minimum values simultaneously.

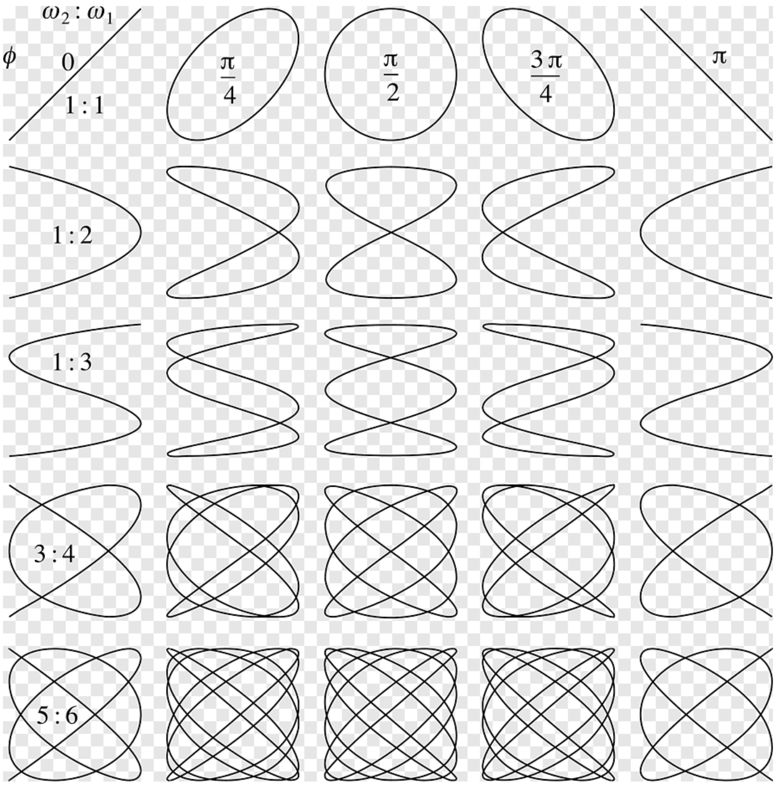
   90° Phase Difference: A phase difference of 90° (or 270°) results in a circular pattern, given that the amplitudes are equal. This implies that the maximum values of the sine waves occur one quarter period apart.

   180° Phase Difference: If one sinusoid is exactly opposite the other (in phase opposition), the Lissajous figure appears as a straight line at a 135° angle to the horizontal. This reflects that the two signals are completely out of sync, reaching their extremes at opposite times.

   The magnitude of the two sine waves also impacts the shape of the Lissajous figures. The amplitudes dictate the elongation of the curves along their respective axes.

   Equal Amplitudes: If the amplitudes of both sinusoids are equal, various phase differences will yield symmetric figures. For instance, with both signals at equal amplitude and a phase difference of 90°, the output will form a perfect circle.

   Different Amplitudes: When the two sinusoids have different magnitudes, the Lissajous pattern stretches along the axis of the sinusoid with the larger amplitude. For example, if one wave has a greater amplitude than the other, the figure will lean towards the dominant waveform's axis, resulting in an elliptical shape rather than a circular one.



2. A square pulse can be generated by feeding a sawtooth waveform and a reference voltage into a comparator circuit built with the LM741 operational amplifier. In this setup, a signal generator provides the sawtooth waveform, while a DC power supply delivers the reference voltage.

A potentiometer is included in the circuit and connected to pin 2 of the LM741 IC. Its role is to form a voltage divider, enabling adjustments to the reference voltage.

When the sawtooth waveform and reference voltage are applied, the comparator outputs a high (positive saturation voltage) or low (negative saturation voltage) signal based on their comparison. Specifically, portions of the sawtooth waveform that exceed the reference voltage result in a high output, whereas portions below the reference voltage produce a low output. This switching behavior generates a square wave at the output.

By altering the reference voltage through the potentiometer, the duration for which the output remains high or low—corresponding to the time intervals above or below the reference voltage—can be modified. This adjustment changes the duty cycle of the square wave, allowing for variations in its pulse width.

4 REFERENCE

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