Lab 6

Creating and Combining Sinusoids in MatLab

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1 Introduction

This lab focuses on the generation, analysis, and combination of discrete-time sinusoidal signals using MATLAB. Sinusoids, particularly sine and cosine waves, are fundamental to signal processing and electrical engineering applications, including biomedical signal analysis. The objective of this lab is to explore how varying parameters—amplitude, frequency, and phase—affect the behavior of sinusoidal signals in both visual and auditory contexts.
By generating, plotting, and combining sinusoids, we will observe the impact of these parameters on the shape, frequency content, and sound of the resulting signals. This hands-on approach deepens understanding of sinusoidal functions, which are integral to the study of circuits and signals, and prepares us for more complex applications in biomedical engineering and signal processing. MATLAB provides an efficient platform for simulating these signals and analyzing their properties, ensuring that we can accurately manipulate and study discrete-time signals.

2 Results

Part I

A.

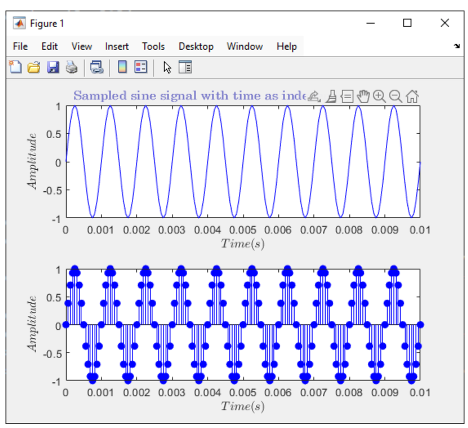

Figure 1: Sinusoidal with $A = 1$, f 1 kHz, $f_s = 16$ kHz, duration = 0.01, and Phase 0

In Figure 1, we observe a sinusoidal signal with an amplitude (A) of 1, frequency (f) of 1 kHz, sampling frequency (f_s) of 16 kHz, duration of 0.01, and phase of 0. This results in 16 samples per cycle. This can be calculated through the formula:

$$F = \frac{f}{f_s} = \frac{1000}{16000} = \frac{1}{16}$$

B.

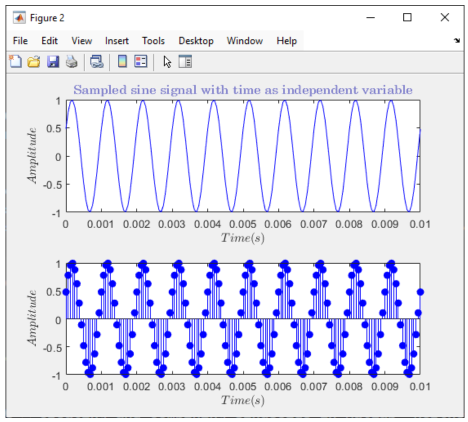

Figure 2: Sinusoidal with $A = 1$, f 1 kHz, $f_s = 16$ kHz, duration = 0.01, and Phase 0.5

As seen in Figure 2, the sinusoidal signal has the same parameters as in part A, with the exception of the phase, which is now 0.5. This phase shift can be seen in the plot, where the signal starts at a different point in the cycle compared to Figure 1. The F value remains the same as in part A and there are still 16 samples per cycle.

C and D.

For parts C and D, the sinusoidal signals have the same parameters as in parts A and B, but with a duration of 1 second. The plots aren't useful for visualizing the signals, but you can hear a beep that lasts one second. The phase shift between parts C and D is not audible.

E.

This part is the same as part D, but with an amplitude of 0.1. The amplitude of the signal is reduced, resulting in a quieter beep. The phase shift is not audible.

F.

For this part, part A is repeated but with sampling frequencies of 7000, 3000, and 1300 Hz.

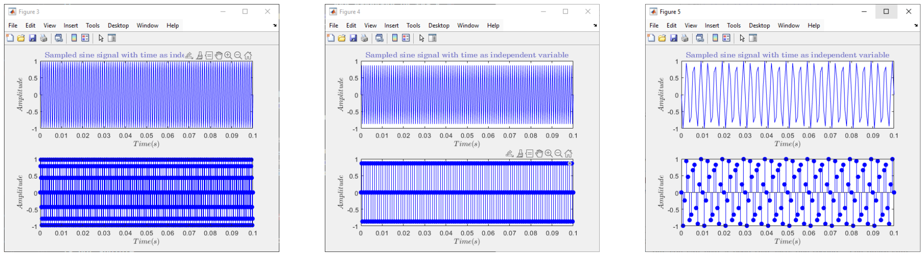

Figure 3: Sinusoidal with f_s = 7 kHz, 3 kHz, and 1.3 kHz

As seen in Figure 3, the sampling frequency affects the number of samples per cycle. The signal with a sampling frequency of 7000 Hz has 7 samples per cycle, the signal with a sampling frequency of 3000 Hz has 3 samples per cycle, and the signal with a sampling frequency of 1300 Hz has 1.3 samples per cycle.

G.

Here, part C is repeated with a sampling frequency of 7000 Hz, 3000 Hz, 1700 Hz, 1300 Hz, and 1100 Hz. The sound of the beep decreases in quality and volume as the sampling frequency decreases. This is because the amount of sound data produced decreases.

Part II

A.

In this part, three sinusoidal signals are generated with frequencies of 1 kHz and amplitude values of 0.1, 0.3, and 1. The signals are then combined and plotted. In 4, the three signals are shown. The signal with an amplitude of 0.1 is green, the signal with an amplitude of 0.3 is blue, and the signal with an amplitude of 1 is red.

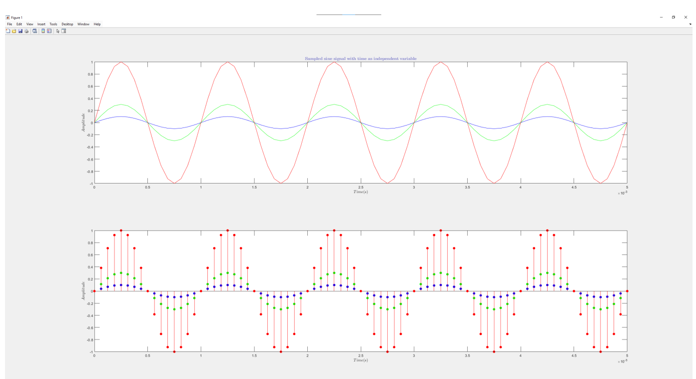

Figure 4: Sinusoidal with A = 0.1, 0.3, and 1

B.

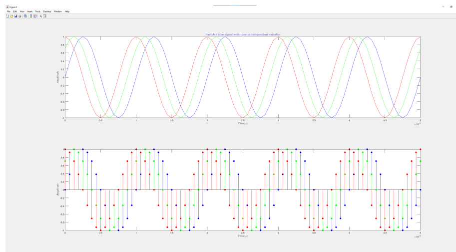

Figure 5: Sinusoidal with phase $\theta = 0$,$\pi/4$, and $\pi/2$

In this part, three sinusoidal signals are generated with phase shifts of 0, $\pi/4$, and $\pi/2$. The signals are then combined and plotted. In 5. This is then repeated with phase shifts of 0, π, and 4π. The signals are then combined and plotted. In 6, the signals are shown.

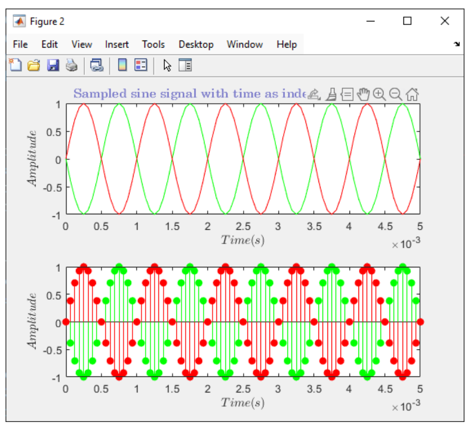

Figure 6: Sinusoidal with phase $\theta = 0$,π, and 4π

C.

Part B is repeated but with 8000 samples instead of 250. Just like the results in Part I, the phase shift is not audible.

Part III

A.

3 Discussion and Conclusion

4 References

[1] Dr. Iman Salama. "Lab 6 – Creating and Combining Sinusoids in MatLab" Northeastern University. 18 October 2024.