Digital Signal Processing SS 2024 – Exercise 3

Digital Signal Processing Tutorial

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Exercise 1

We have the analog signal

$$x(t) = x_1(t) + x_2(t) = \sin(2\pi f_1 t) + \sin(2\pi f_2 t)$$

with $f_1 = 4\text{kHz}$ and $f_2 = 6\text{kHz}$. The signal is sampled with a sampling frequency of $f_s = 10\text{kHz}$.

a) In Figure 1 we draw the spectrum of $x(t)$. This was derived analytically by observing that $x(t)$ is composed of two separate sinusoidal signals.

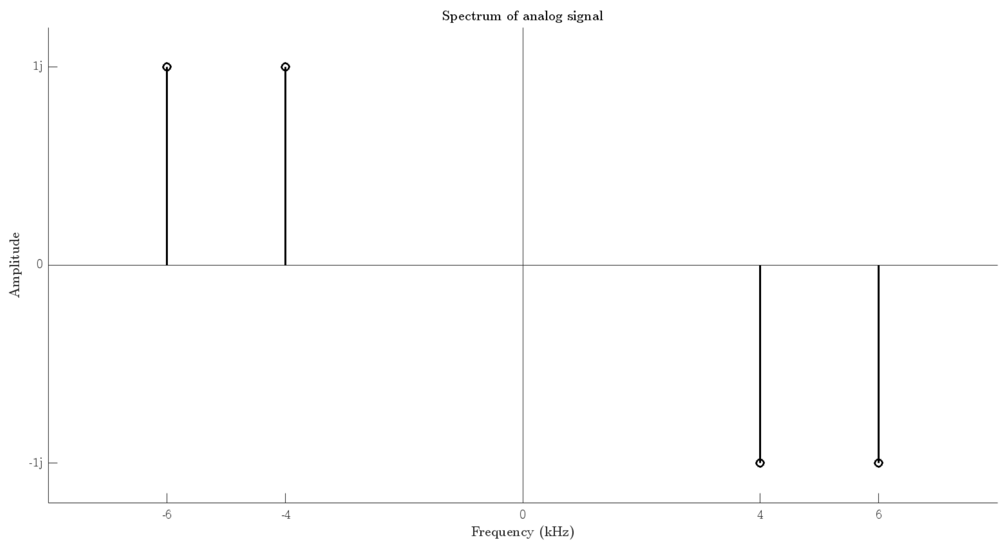

Figure 1: Spectrum of $x(t)$

b) In Figure 2 we draw the spectrum of $x(t)$ shifted by $-f_s$, 0, and $+f_s$, as well as the result of adding up the shifted spectra.

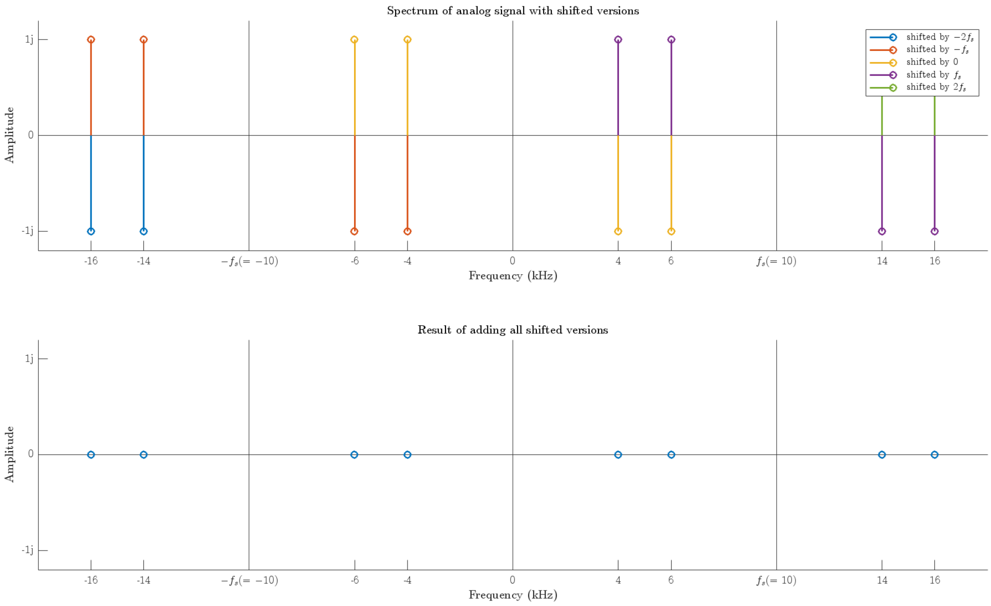

Figure 2: Spectrum of $x(t)$ shifted

c) In Figure 3 we draw the first 2ms of the signal $x(t)$ and the resulting signal after sampling with $f_s = 10\text{kHz}$. As we can see, $x[t] = 0$, and therefore the spectrum will also be constant 0.

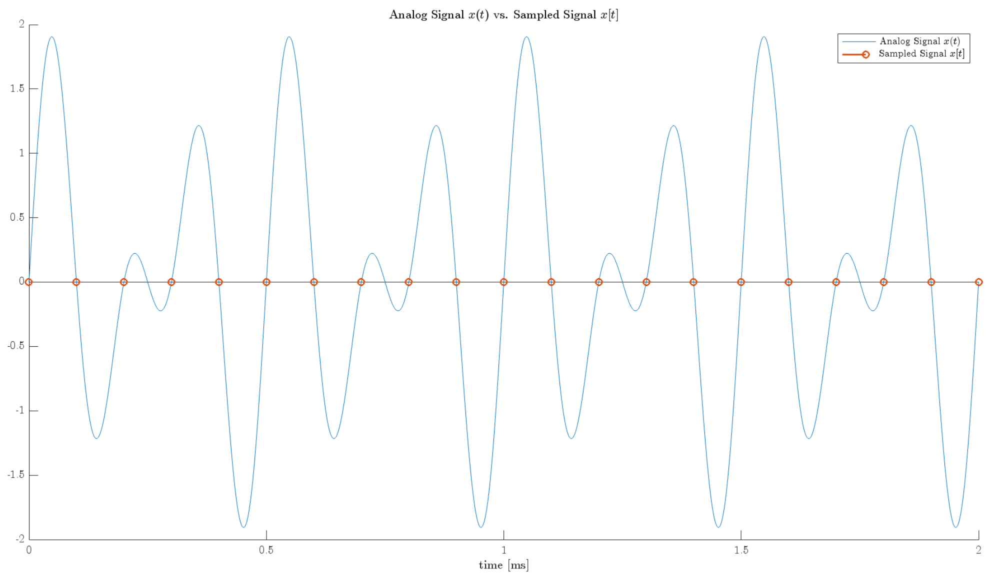

Figure 3: $x(t)$ and $x[t]$

Exercise 2

Exercise 3

Exercise 4