Neuroprothetik Exercise
Exercise 1

Nico Hertel

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1 Generate a Signal

The task was to plot the time-domain of the signal, described by the equation 1 with a sampling rate of 100 kHz

$$x = 3 + sin(2\pi * 100Hz * t) + 1.5 * sin(2\pi * 600Hz * t) + 2 * sin(2\pi * 9kHz * t) \quad (1)$$

Figure 1 shows the resutling plot the signal .

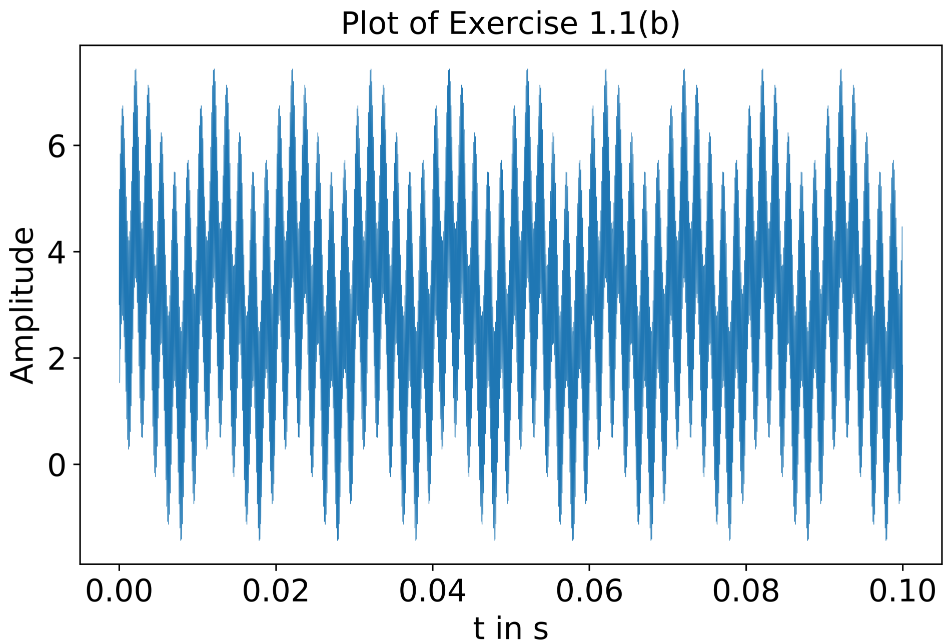

Figure 1: Plot of equation 1 in the time-domain

2 Calcualte the Spectrum

The task was to calculate the spectrum of equation 1 but with the different sampling rates: 10 kHz, 20 kHz and 100 kHz. Figure 2 shows the plot of the FFT for all three sampling rates. As one can see, the plot for a sampling frequency of 10 kHZ does not show the expected peaks at 100 Hz, 600 Hz and 9 kHz, but at 100 Hz, 600 Hz and 1000 Hz. This is due to the violation of the Nyquist-Theorem, which sets the minimal sampling frequency $f_{sampling,min}$ of a signal with a maximal frequency $f_{signal,max}$ to:

$$f_{samplig,min} > 2 * f_{signal,max} \tag{2}$$

As the maximal frequency in 1 is 9 kHz, using only 10 kHz as the sampling rate will violate this theorem. This causes the peak in the first plot in 2 at 1000 Hz instead of 9 kHz.

To prevent this from happening, one has to filter the signal before sampling, using an adequate lowpass filter to remove any frequencys in the signal that would violate 2. In this case, with sampling frequencys of 10 kHz, 20 kHz and 100 kHz, this would mean a lowpass filter with a cutoff-frequency of maximal 5 kHz, 10 kHz and 50 kHz respectively.

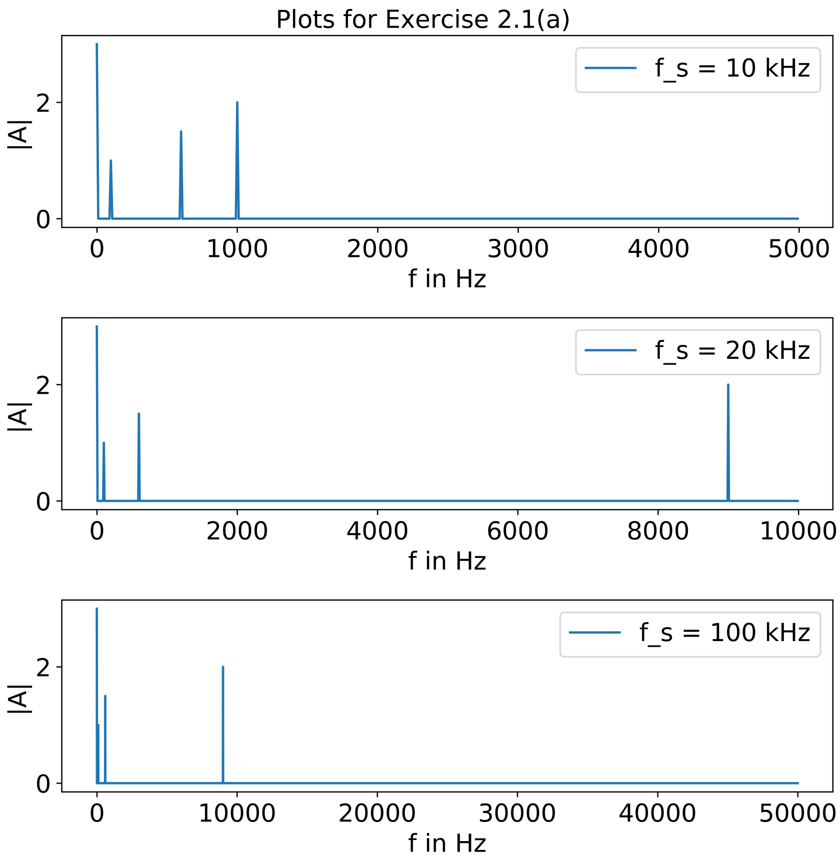

Figure 2: Plot of equation 1 in the frequency-domain for three samping rates (from top to bottom: 10 kHz, 20 kHz, 100 kHz