Neuroprothetik Exercise 1
Introduction

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1 Generate a Signal

a) Create a Matlab function that takes the following inputs: *a)* An array of frequencies (in Hz) *b)* An array of amplitudes *c)* The signal duration (in seconds) *d)* the sample rate (in Hz) and which returns a signal as given in Eqn. 1 and the time axis of this signal.

$$f(t) = A_0 + \sum_{i=1}^{n} A_i \sin(2\pi F_i \cdot t) \quad (1)$$

where A_i is the amplitude of the frequency component F_i and A_0 is the signal offset

1.1 Plot the Signal

a) Use this function to generate a one second long signal consisting of the frequency components 100 Hz, 600 Hz and 9 kHz with the amplitudes 1, 1.5 and 2 as well as an offset of 3 at a sampling rate of 100 kHz.

b) Plot the first 100 ms of this signal.

2 Calculate the Spectrum

We now want to calculate the single sided amplitude spectrum (positive half) of the Signal using the Fast Fourier Transformation. This can be easily done in Matlab by using the fft(*signal*) command. In Python we use numpy.fft.fft(*signal*)

a) Write a Matalb function that calculates the single sided amplitude spectrum of a given Signal.

   To get the right amplitude values, you have to divide the values returned by the fft() function by the number of input samples. To get the single sided amplitude spectrum, add up the negative and positive frequency bins.

2.1 Plot the Spectrum

a) Plot the spectrum of the same signal as generated in section 1 but for sample rates of 100 kHz, 20 kHz and 10 kHz.

b) Explain what you see in these spectra and what you would have to to if you would want to record such a signal with the given sample rates.

3 Solution

Here you can see how the resulting plots should look like. This is just to give you an idea if your results are valid.

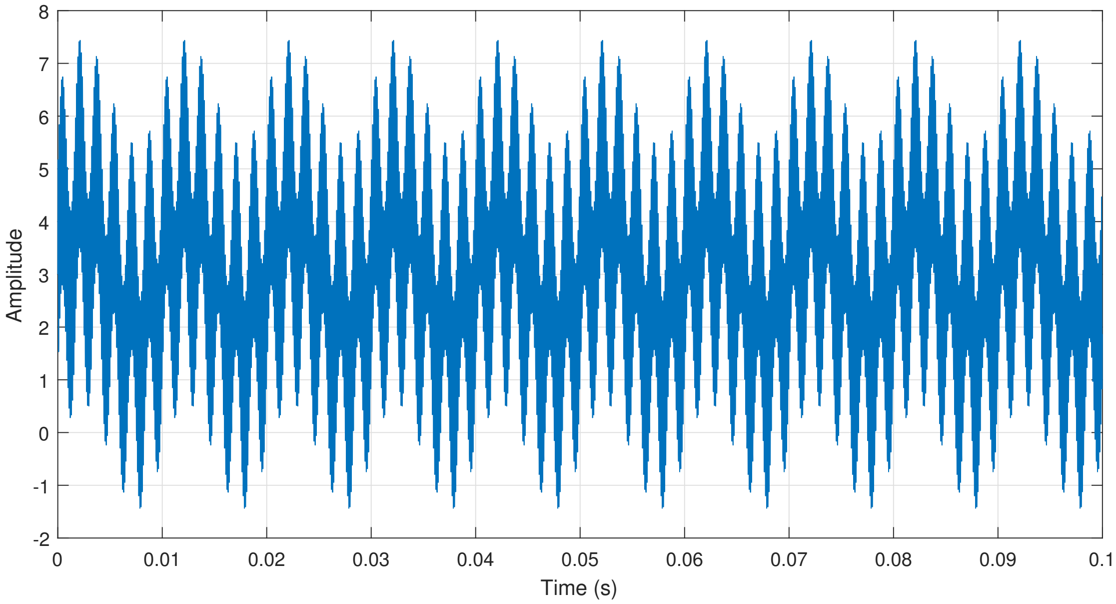

Figure 1: Solution to 1.1. The first 100 ms of the created signal which was sampled with a sampling-frequency of 100 kHz.

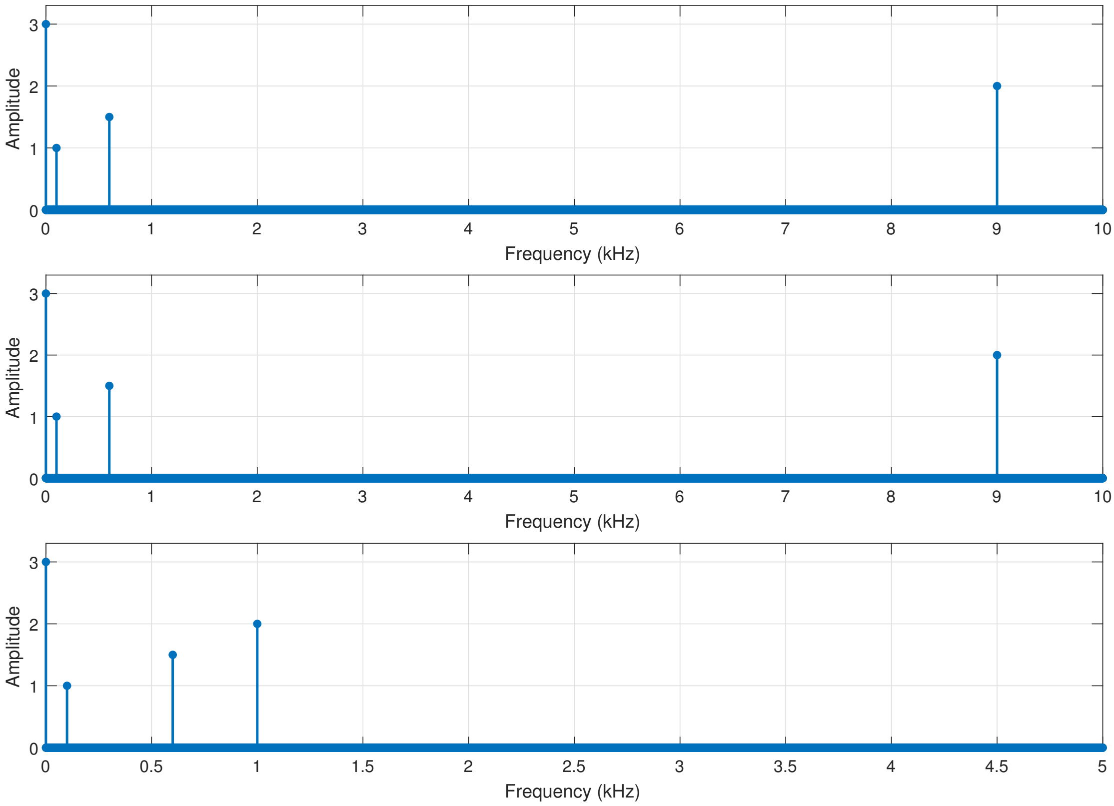

Figure 2: Solution to 2.1. Different FFTs of the signal shown in figure 1. Top: sampling frequency is 100 kHz, only frequencies up to 10 kHz are shown. Middle: sampling frequency is 20 kHz. Bottom: sampling frequency is 10 kHz.