

Assignment 2

Hand in a concise report, documenting and discussing the results and outcomes of the two questions a) and b) below. Add to the report a listing of the program used for question b).

a) Exercise 1a and 1b of chapter 4.

b) Read chapter 5 of the lecture notes on digital signal processing.

Now consider the signal $x_k = \sin(2\pi f_1 k \Delta) + 0.1 \sin(2\pi f_2 k \Delta)$, $k = 0, \dots, N - 1$

Here, $\Delta = 1$ ms, $N = 128$ and $f_1 = 100$ Hz and $f_2 = 125$ Hz. Make a program (Python or Matlab) to simulate this signal and for applying the steps below.

- i) Calculate the DFT X_r of x_k and make a plot of the values of $|X_r|$ as a function of the corresponding frequency. Estimate the frequency and **relative** amplitude, i.e. relative to the amplitude of the first sine, of the second sine in the signal from this plot.
- ii) Add zeros to the signal x_k up to 2048 samples, i.e. 1792 zeros are added to the signal (called 'zero padding'). Calculate again the DFT X_r of x_k and make a plot of $|X_r|$ versus frequency. Estimate again the frequency and relative relative amplitude of the second sine in the signal from this plot. Compare it with the results of question (i).
- iii) Now first apply Hanning weighting to the original signal x_k (**consisting of 256 samples**).

Subsequently apply zero padding to the signal up to 2048 samples. Finally, calculate again the DFT X_r of x_k and make a plot of $|X_r|$. Estimate now the frequency and relative amplitude of the second sine in the signal from this plot. Compare with the results of question (ii).

- iv) Provide a short interpretation of the above estimates for frequency and relative amplitude of the second sine. Is the Hanning weighting needed for obtaining accurate estimates? Is zero padding needed for obtaining accurate estimates?