

Work 1

FREQUENCY ANALYSIS OF SIGNALS USING MATLAB

C) Frequency analysis 2

In this part we examine frequency characteristic of square wave (command square), sawtooth wave (command sawtooth) and cosine wave with linearly increasing frequency (command chirp) with FFT.

You can use the listing made in part B as ground for the frequency analyses.

C1. ● Change the listing so that signal x becomes square wave with frequency of 120 Hz. Peak value of the signal is 1 volt and pulse ratio 50 percent. Use Matlab's Help to get information of square command! Notice that you are able to copy text from Help, for example the command! Remember to put coefficient 2π for the frequency.

● Change the scales to be more illustrative and the name labels of the scales and titles more descriptive.

● Change command `semilogy(F, X)` to form `plot(F, X)` to make the vertical axis in frequency domain linear.

● Save the file to a directory that assistant names by name square1. Run the file and make possible corrections to listing. Check that the graphs are clearly interpretable! Finally print the graphs (1) to your group. Listen the signal x with `sounds`-command if you didn't do it earlier.

@ Answer the following questions with help of course book or hand-outs.

@ Which similarities are there between the spectrum you printed and the presentation for square wave's spectrum in course book / hand-out?

@ Which differences are there?

@ Where do possible differences result from?

● Change the frequency scale of FFT to be in range of 0 – F_s . Change also the title of the macro. Print the graph.



@ Explain the structure of the printed spectrum! You may find some help from the hand-outs (p.65).

C2. ● Change signal x to be sawtooth wave. Frequency, amplitude and shape are the same as with square wave. Notice that the form factor for sawtooth wave is 0,5 instead of 50. Form factor determines the place of signals peak value during the cycle. Matlab's Help is useful again!

● Make needed changes in listing and save file to the directory named by assistant by name sawtooth1. Run file and make possible corrections. Change the frequency scale of FFT to range $0-F_s/2$, so we don't see repeated spectrum components caused by sampling. Change also other scales if needed and give an appropriate title for the print, and print the graphs.

● You can think over the next questions for a while now. **They are assumed to be answered in the report!**

- @ Which similarities and differences are there between the spectra calculated in preliminary questions and now printed for sawtooth wave?
- @ How well does the frequency spectrum that FFT calculates for sawtooth wave correspond to earlier calculated or presented in this course?
- @ Which similarities and differences are there between spectra of sawtooth and square wave?
- @ How is sawtooth wave formed mathematically from square wave?
- @ Present Fourier series of a sawtooth wave!

C3. ● Open file square1.m. Change the pulse ratio of square wave to 10 percent. Now the signal stays in its higher value for 10 percent of a cycle. Change also scaling and both name labels for axes and title, if needed. Save the file to the directory named by assistant by name square2. Run the file and make possible corrections to the listing. Make changes to scaling if needed, and finally print the graphs.

Solve the following problems now and show the results to the assistant before going on!

- Sketch a sinc-curve (actually its absolute value) to the printed spectrum. Mark zero-points of the sinc-curve to the picture!
 - Why is there an impuls also at 0 Hz? _____
 - What happens to the spectrum if the pulse ratio of square wave decreases?
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