REPORT

Classes: Analog and Digital Electronic Circuits

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| Laboratorium No. 2  Date: 28.10.2023  Topic: „Windowing"  Version 6 | Adam Kubliński  Informatyka  II stopień, niestacjonarne, zaoczne,  I semestr, gr. 1A |

GitHub Repository: <https://github.com/Adamadacho/Analog_and_Digital_Electronic_Circuits.git>

# Topic of the laboratory

# The objective is to be able the results of different type of windowing the signals.

# Task

Generate three sine signals of given f1, f2, and f3 and amplitude |x[k]|max for the sampling frequency fs in the range of 0 ≤ k < N accordingto variant 6. Complete inputs are highlighted in the table below.

Obraz zawierający tekst, zrzut ekranu, Czcionka, numer

Opis wygenerowany automatycznie

The code has been done according to instruction and has been adjusted to the variant 6. It was made in Jupyther Notebook.

Obraz zawierający tekst, zrzut ekranu, wyświetlacz

Opis wygenerowany automatycznie

Obraz zawierający tekst, zrzut ekranu, wyświetlacz, oprogramowanie

Opis wygenerowany automatycznie

Results of the laboratory are presented below

* The "normalized" level of the DFT spectra.

Obraz zawierający Wykres, linia, diagram

Opis wygenerowany automatycznie

* The window DTFT spectra normalized to their mainlobe maximum. The intervals for f, Ω, and amplitudes

Obraz zawierający tekst, linia, Wykres, diagram

Opis wygenerowany automatycznie

# Conclusions

Based on the uploaded images showing graphs of time windows and their amplitude spectrum on a decibel scale, we can interpret the results in terms of the best case and worst case for different windows. The first chart shows three different time windows:

* Rectangular
* Hanning (hann)
* Flat (flattop)

The second and third graphs show the spectrum of signals multiplied by windows on the decibel scale. They show the frequency domain response for the best and worst case using each window. "Best case" usually means a signal at a frequency that exactly matches one of the FFT bins (called the frequency bin), while "worst case" refers to a frequency located between the bins, which causes the signal energy to be diluted between adjacent bins.

The second graph shows that the rectangular window has a very sharp peak, but also high sidelobes, which leads to a high level of spectral leakage. Hanning and planar windows, on the other hand, have lower side lobes, which means that spectral leakage is significantly reduced.

Reasons for differences in results for frequency signals f1 and f2 may be related to their location relative to the FFT bins. A signal with a frequency exactly matching the FFT bin (best case) will not blur and will have a clear, sharp peak in the spectrum. On the other hand, a signal with a frequency located between FFT bins (worst case) will spread the energy between adjacent bins, resulting in a less pronounced peak and a higher level of spectral leakage.

These spectra are used to analyze how windows affect resolution and spectral leakage in the Fourier transform, which is critical in applications such as signal analysis, image processing, and communications systems. The choice of window depends on the specific application and the desired compromise between resolution and spectral leakage.