Signals & Systems

Laboratory no. 4 – Signal processing in frequency domain

Exercise 1.

Generate a few second signal composed of three sine waves of frequencies: 10, 80 and 120 Hz. Amplitude of the signals should be in the proportions 1:3:1 and the phase should be shifted by about 20^o.

Exercise 2.

Create the Fourier transform of the signal generated in Ex. 1 and show it graphically in the form of graphs amplitude-frequency and phase-frequency. Pay attention to the selection of an appropriate sampling frequency and the proper frequency axis scaling. Add a vertical line to indicate the Nyqiust frequency. Comment on the obtained results.

Exercise 3.

Change the sampling frequency of the signal from Ex. 1 to place the Nyquist frequency at 100 Hz and repeat Ex. 2 removing also the sine wave frequency 80 Hz. Comment on the results.

Exercise 4.

Perform an inverse Fourier transform of the signal from Ex. 1, and compare the results with the original signal. The comparison should be done by plotting two graphs in one axis.

Exercise 5.

Perform the Fourier transformation of the following signals:

- two pulses occurring in close proximity,
- random noise,
- Heaviside function,
- Saw-tooth signal,
- Rectangular wave.

Exercise 6.

Generate a sinusoidal signal with frequency of 11 Hz sampled at a frequency 200Hz. Prepare two realizations of this signal: one with a length of 1s and the other with a length of 0.95s. Perform the Fourier transformation for both prepared signals. Plot absolute values of both results in one axis. Comment on the results obtained.

Exercise 7.

Repeat the experiment from Ex. 6 imposing the Hanning window on the signals. Comment on the results.

Exercise 8.

Modify the test signal created in Ex. 1 by adding two sinusoids with frequencies of 12 and 81 Hz. Perform a comparison of different time windows applied to the test signal. Check what impact has the length of the window on the output spectrum.