Lab 6

Fourier Transform and Discrete-Time Fourier Transform

Exercise 1

Matlab filename must be `exer01.m`.

A non-periodic signal $x(t)$ is given by the expression below:

$$x(t) = e^{-t^2/t_0^2}$$

where $t_0 = 1ms$

Part 1: Fourier Transform (4 points)

a) Use Matlab's Symbolic Math Toolbox (SMT) to obtain the expression of the Fourier Transform $X(f)$ of $x(t)$.

b) Define two anonymous functions in Matlab to describe $x(t)$ and $X(f)$ with t_0 as input parameter.

c) Determine analytically (you can use the SMT from Matlab) the energy of signal $x(t)$.

d) Using the anonymous function $X(f)$ determine the frequency f_{max} at which the energy of the signal $x(t)$ for frequencies $f > f_{max}$ is 120dB below the total energy of the signal $x(t)$.

e) Based on the value of f_{max} select an appropriate value for the sampling frequency f_s.

f) Repeat the problem for SNR=60dB and determine f_max and f_s.

Part 2: Discrete-Time Fourier Transform (6 Points)

a) Sample $x(t)$ at f_s in the time interval approximately around $[-3t_0, 3t_0]$ to generate a discrete signal $x[n]$. Make sure that the sampling includes the sample at $t = 0$ and that the signal is symmetric.

b) Determine the number of sampling points needed.

c) Compute the Discrete-Time Fourier Transform of $x[n]$ in the frequency range from $F = [-1/2, 1/2]$. Plot the $X(F)$ obtained here with the value of $X(f)$ from Part 1 and use the corresponding factor to make them comparable.

d) Explain the differences between $X(f)$ and $X(F)$. Also explain the results for SNR=120dB and SNR=60dB.