Strict submission deadline: 26 May 2025 at 08:00 am.

Exercise #4

Task 4.1 Signal Analysis

Analyze the sampled time signal given in the CSV (comma separated values) file "testsignal". The only pre-knowledge is the sampling frequency which is 500 Hz. Use Matlab to read the file, determine the length of the signal in sampling points and seconds, analyze the signal and determine the PSD using the Wiener-Khintchine theorem. Use Matlab to find the highest peak of the PSD and read the corresponding frequency. Print it as the "main frequency". Plot the signal and the PSD. Discuss your results.

Submit the solutions (Matlab source code, all plots, and written answers)

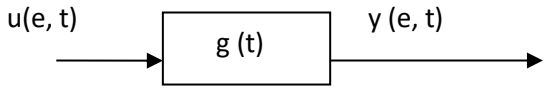
Task 4.2 Digital Signal Synthesis

Write a Matlab program. Your task is to synthesize a digital signal. Create a cosine signal. It's frequency should be the "main frequency" from task 4.1. The sampling frequency should be 2 kHz. The legth of the signal in seconds should be the same as the signal in task 4.1. Plot the first 100 sampling points of the signal. Plot the ACF of the signal from -1s to +1s.

Submit the solutions (Matlab source code, all plots, and written answers)

Task 4.3 Power spectral density and transfer function

A Gaussian noise signal u(e, t) is input to a linear system described by its impulse response g(t).



Some power spectral densities are given:

$$S_{uy} = \frac{S_1}{(1 - j\omega b)(1 + j\omega T_1)} \qquad S_{yy} = \frac{S_1}{1 + \omega^2 T_1^2}$$

a) Determine the transfer function G(jω) of the linear system.
b) Is the system described by G(jω) a causal system? Explain your statement.
c) Calculate the autocorrelation function $s_{uu}(\tau)$ of the input signal u(e, t). (Hint: Use a Fourier transform table)

Submit the calculation path and the solution.