Strict submission deadline: 5 June 2023 at 10:00 am.
Submit a PDF or Word document for calculations and plots. Submit Matlab source code for Matlab programs. Use the submit button.

Exercise #3

Task 3.1

Let a random process

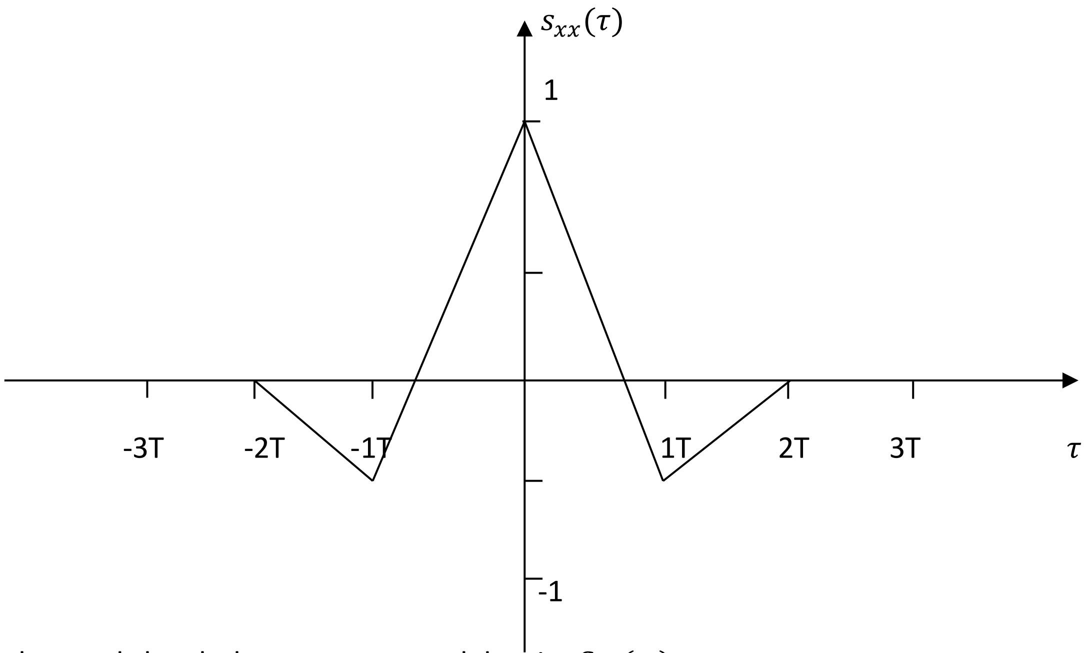
$$x(\zeta, t) = \sin(2\pi f t) + \sin(3\pi f t) + \alpha \cdot n(\zeta, t)$$

The frequency f is 300 Hz, α is 0.1, and n(ζ, t) is normally distributed random noise. An A/D converter takes samples of a pattern function of the process with a sampling frequency of 3 kHz. The length of the buffer of the A/D converter is 2048.

a) Write a Matlab program that calculates and plots the PSD (power spectral density) of the sampled pattern function random process x(ζ, t) using the Wiener-Khintchine theorem. Don't use the Matlab function for direct PSD calculation. Use the Matlab function "randn" for the noise. Plot the sampled time signal in the timeframe from +0.00s to +0.02s, and plot the PSD (positive frequencies only). Don't forget the axis labels.
b) Increase α to 0.3 and run your program again. What do you observe? Submit the plots.
c) Increase α to 2.0 and run your program again. What do you observe? Submit the plots.
d) Run your program with α set to 0.3 and the sampling frequency to 900 Hz. Submit the plots.
e) Run your program with α set to 0.3 and the sampling frequency to 450 Hz. Submit the plots. Explain the results.
f) Run your program with α set to 0.3 and a sampling frequency of 3 kHz. In contrast to b) the buffer of the A/D converter now should have a length of 8192. Submit the plots.
g) Take the settings of f) but instead of normally distributed random noise add uniformly distributed noise.

Task 3.2

This is the autocorrelation function $s_{xx}(\tau)$ of the stationary test random process x (ζ, t):



Calculate and sketch the power spectral density $S_{xx}(\omega)$.