Stochastic Signals and Systems

Exercises

1 Task 4.1

Given is the following signal

$$x(t) = A_1 sin(2\pi f_1 t) + A_2 cos(2\pi f_2 t)$$

where, frequencies f_1 and f_2 are 5 Hz and 18 Hz respectively and amplitudes A_1 and A_2 are 1 and 0.6 respectively.

a) Find the power spectral density of the signal $x(t)$ using MATLAB. What is the effect of changing number of samples and sampling frequency on power spectral density, e.g. 1000 Hz, 500 Hz and 200 Hz?

b) What happens when sampling frequency becomes less than Nyquist sampling frequency? In this case, is there any relation between Nyquist sampling frequency, maximum signal frequency and the frequency component present in the power spectral density?

2 Task 4.2

Given is the following signal

$$x(t) = A_1 sin(2\pi f_1 t) + A_2 cos(2\pi f_2 t)$$

where, frequencies f_1 and f_2 are 5 Hz and 20 Hz respectively and amplitudes A_1 and A_2 are 1 and 0.6 respectively.

Find the power spectral density of the signal $x(t)$ using both Wiener Khintchine Theorem and Fourier Transform Squaring method. Also, use both Rectangular Window and Hamming Window.

3 Task 4.3

Given is the following random process with random noise added to it

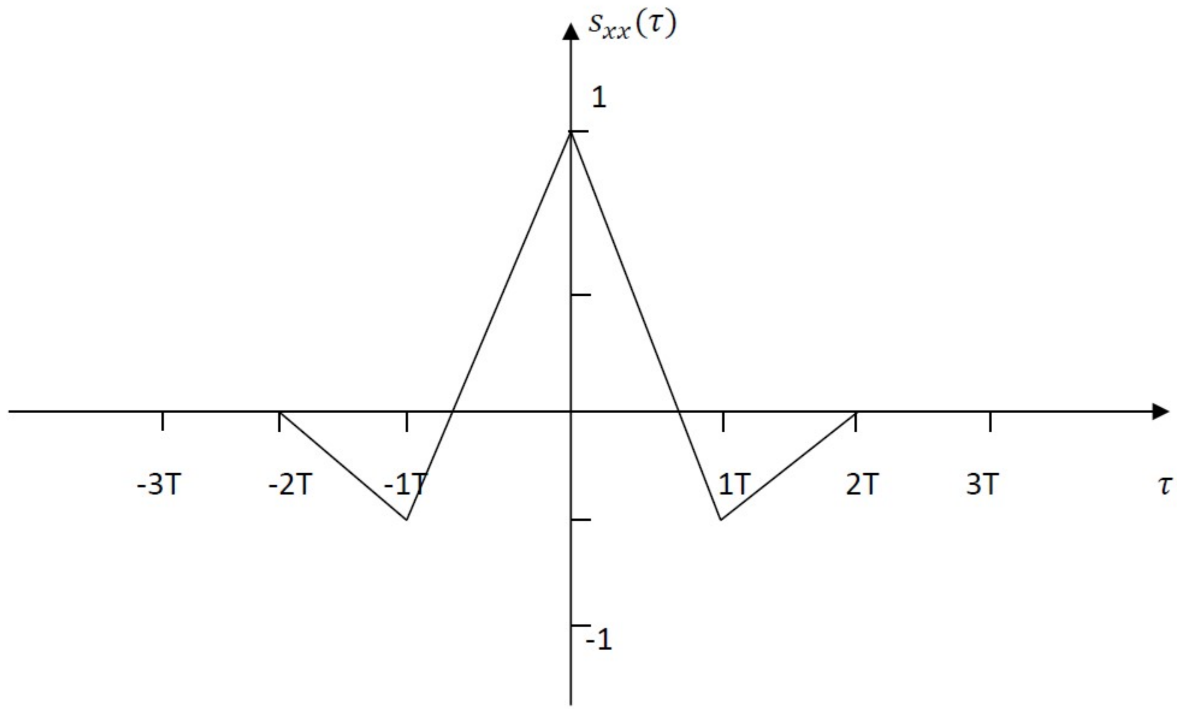
$$x(\zeta, t) = \sin(2\pi f t) + \alpha \cdot \eta(\zeta, t)$$

where, frequency f is 1 Hz, α is 0.05 and $\eta(\zeta, t)$ is random noise.

Find the power spectral density of the random process $x(\zeta, t)$ using both Wiener Khintchine Theorem and Fourier Transform Squaring method. Also, use both Rectangular Window and Hamming Window.

4 Task 4.4

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



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