Strict submission deadline: 19 June 2023 at 11:30 am.
Submit a PDF or Word document for calculations and plots. Submit Matlab source code for Matlab programs.

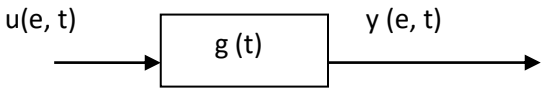
Exercise #5

Task 5.1 Digital Signal Synthesis

Write a Matlab program. Synthesize the digital signal that you analyzed in task 4.1 based on the calculated PSD. The timeframe of the synthesized signal and the original signal should have the same length. Plot the signal.

Task 5.2 Power spectral density and transfer function

A Gaussian noise signal u(e, t) is input to a linear system which is 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).

Task 5.3 Cross-correlation function

Let a stationary random process x(ζ, t)

$$s_{xx}(\tau) = a\, e^{-\alpha|\tau|} + b$$

Known are the mean (=0), the standard deviation (=1), and the autocorrelation function.

Let a random process y (ζ, t),

$$y(\zeta, t) = \begin{cases} 0 & for\ t \le t_0 \\ \int_{t_0}^{t} x(\zeta, \lambda) d\lambda & for\ t > t_0 \end{cases}$$

a) Determine the constants a and b.
b) Determine the cross-correlation function $s_{xy}(t_1, t_2) = E\{x(\zeta, t_1)\, y\, (\zeta, t_2)\}$
c) Is y (ζ, t) a stationary process?