

ETT_2026 Digitaalinen Signaalinkäsittely Exam

March 06, 2017

1. Describe the following. (3 p)
 - a) Linear time-invariant system and its properties.
 - b) System stability and system casuality.
 - c) Specify some of the basic purposes of filters and give type of applications where the filters are needed.
2. Explain the following. (3 p)
 - a) The fundamental idea of adaptive signal processing.
 - b) How LMS algorithm operates and its purpose in adaptive filtering, include block diagram of LMS based adaptive signal processing?
 - c) Give list of applications where adaptive signal processing is used and what are its benefits compared to non-adaptive signal processing?
3. The impulse response of a system is given as follows $h(n) = \{0.5, 1, 1.5, -1, 2.5, -1, 1.5, 1\}$ (8 pt)
 - a) Determine the corresponding frequency response at frequency $\omega = 0.5 \cdot 2\pi$.
 - b) Determine the amplitude and phase response at frequency $\omega = 0.5 \cdot 2\pi$.
4. Design a highpass FIR filter that satisfy the given specifications using window based design method: $\omega_s = 0.3\pi$, $A_s = 50$ dB, $\omega_p = 0.5\pi$, and $A_p = 0.001$ dB. (8 pt)
 - a) Use an appropriate fixed window to obtain a minimum order linear-phase filter and determine the coefficients of the impulse response of the filter and plot it.
 - b) What will be the order of the filter if it uses Kaiser window?
5. The system function of a discrete-time LTI system is as follows (8 pt)

$$H(z) = \frac{z^2 + 0.3z + 1}{z^2 + 0.3z + 0.8}$$

- a) Determine the time-domain difference equation of the system.
- b) Draw direct form II structure of the system.
- c) Calculate the output of the system when the input is $x(n) = 3 + \sin(0.5\pi n)$
- d) Is the system stable, why?