

ETT_2026 Digitaalinen Signaalinkäsittely Exam

May 09, 2018

Students are allowed to use only calculator. The necessary equations and references are given in the last two pages of this exam paper.

1. Describe the following. (5 p)
 - a) Linear time-invariant system and its properties.
 - b) Specify some of the basic purposes of filters and give type of applications where the filters are needed.
 - c) Give list of applications where adaptive signal processing is used and what are its benefits compared to non-adaptive signal processing?
 - d) Define multirate signal processing and why it is needed?
 - e) Describe the purpose of FFT and its applications?

2. The impulse response of a system is given as follows $h(n) = \{0.5, -3, -2, 1, 0, 4\}$ (4 pt)
 - a) Determine the corresponding frequency response at frequency $\omega = 0.5 * 2\pi$.
 - b) What is the system response if the system input is $x(z) = 1/1-z^{-1}$

3. Design a lowpass FIR filter that satisfy the specifications: $\omega_p = 0.3\pi$, $A_p = 0.5$ dB, $\omega_s = 0.5\pi$, and $A_s = 50$ 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?

4. The system function of a discrete-time LTI system is as follows (8 pt)

$$H(z) = \frac{z^2 + 0.3z + 1}{z^2 + 0.2z + 1.4}$$

- 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?