Chapter 1 – Introduction and Basics

Problem 1.1

At the input of a digital FIR filter with the impulse response

$$h(k) = \gamma_0(k) + \gamma_0(k-1)$$

the sequence

$$s(k) = 2\gamma_0(k) + \gamma_0(k-1)$$

is applied. Before the filter was in zero state.

1.1.1 Determine the system function $H_\mathrm{z}(z)$ of the digital filter, as well as the z-transformed $S_\mathrm{z}(z)$ of the input sequence $s(k)$.

1.1.2 Draw the pole zero plot of $H_\mathrm{z}(z)$. Which kind of filter is described by the given impulse response?

1.1.3 Determine the z-transformed $G_\mathrm{z}(z)$ of the output sequence $g(k)$, for the case that the given sequence $s(k)$ is applied at the input.

1.1.4 Determine the output sequence $g(k)$ and draw $g(k)$ over k.

1.1.5 Determine a system function $H_{1\mathrm{z}}(z)$ of a new digital filter, which reacts to the input of the unit step sequence $\gamma_{-1}(k)$ with the in 1.1.4 calculated output $g(k)$.

1.1.6 Give the impulse response $h_1(k)$ of the digital filter designed in 1.1.5.

1.1.7 Draw a canonical structure of the digital filter designed in 1.1.5.

Problem 1.2

Given are the poles and zeros of the system-function $H_\mathrm{z}(z)$ of a digital-filter:

$$z_{\infty 1} = +\mathrm{j}0.5 \qquad z_{\infty 2} = -\mathrm{j}0.5 \qquad z_{01} = +1$$

1.2.1 Draw the pole zero plot.

1.2.2 Determine the system-function $H_\mathrm{z}(z)$.

1.2.3 Draw the non-canonical 'direct structure' of the described digital-filter.

1.2.4 Draw a 'canonical structure' of the described digital-filter.

1.2.5 Determine the poles and zeros of the Laplace-Transformed $H_\mathrm{aL}(p)$, which are related to the system function $H_\mathrm{z}(z)$ over $H_\mathrm{aL}(p) = H_\mathrm{z}(z = \mathrm{e}^{pT_\mathrm{a}})$.

1.2.6 Which kind of filter is described by the given system function?