2^{nd} Exercise in Digital Information Processing

1. Are the following systems LTI-systems?

   a) $y(t) = x(t) + b$

   b) $y(t) = x(t)m(t)$

2. Discrete convolution

   - Compute the linear convolution for $x[n]$ and $h[n]$.

     $$x[n] = \{\ldots, 0, \underline{2}, 7, -5, 3, 4, 0, \ldots\} \quad \text{und } h[n] = \{\ldots, 0, \underline{2}, -5, 4, 1, 0, \ldots\}$$

   - Assume the signals are periodic with the values for $n = 0, 1, 2, 3$. Compute the periodic convolution.

3. Compute the Z-transform $Z\{x[n]\} = X(z) = \sum\limits_{n=-\infty}^{\infty} x_n z^{-n}$ of the signals

   a) $Z\{ax[n] + by[n]\}$ b) $Z\{x[n-i]\}$ c) $x[n] = \begin{cases} 1/4 & n = 1, 2, 3, 4 \\ 0 & \text{otherwise} \end{cases}$

4. Compute the Z-transform of the signals

   $$\text{a)} \quad x[n] = \begin{cases} a^n & n \geq 0 \\ 0 & \text{otherwise} \end{cases}, \qquad \text{b)} \quad x[n] = \begin{cases} -a^n & n \leq -1 \\ 0 & \text{otherwise} \end{cases}.$$

   Compare the results!

5. Show that for the Z-transform $Z\{x[n]\} = X(z) = \sum\limits_{n=-\infty}^{\infty} x_n z^{-n}$

   - the convolution theorem

     $$Z\{x(n) \star h(n)\} = X(z) \cdot H(z)$$

     is valid,

   - and for the derivation of the Z-transform

     $$-z\frac{dF(z)}{dz} = Z\{n \cdot f[n]\}$$

     is valid.