ISS – Numerical exercise V. – Discrete Systems

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Example 1 – FIR

Diven a discrete system (filter) with transfer function:

$$H(z) = 1 - 0.9z^{-1}$$

(called a preemphasis filter in speech signal processing).

1. Define its transfer function as fraction $H(z) = \frac{B(z)}{A(z)}$, compute polynoms coefficients.
2. Draw its diagram.
3. Define its difference equation.
4. Find filter's impulse response.
5. Locate its poles and nulls, by their means define transfer function.
6. Using poles and nulls values, approximate filters frequency characteristic behaviour. Focul on frequency $\omega = \frac{2\pi}{8}$.
7. Process the signal from the previous numerical exercise:

   $$x[n] = 5\cos\left(\frac{2\pi}{8}n + \frac{\pi}{2}\right).$$

   Verify, whether the folloing holds:

   $$y[n] = |H(e^{j\omega_1})|C_1\cos(\omega_1 n + \phi_1 + \arg H(e^{j\omega_1})).$$

8. Define a C function that implements the filter.

Example 2 – IIR

Given a discrete system (filter) with transfer function:

$$H(z) = \frac{1}{1 - 1.34z^{-1} + 0.90z^{-2}}$$

1. Define its transfer function as fraction $H(z) = \frac{B(z)}{A(z)}$, compute polynoms coefficients.
2. Draw its diagram.
3. Define its difference equation.
4. Locate its poles and nulls, by their means define transfer function.
5. Find its resonance frequency and module and phase of its frequency characteristics at that frequency.
6. Process the signal from the previous numerical exercise:

   $$x[n] = 5\cos\left(\frac{2\pi}{8}n + \frac{\pi}{2}\right).$$

7. Define a C function that implements the filter.