

**Digital Signal Processing**

17/01/2022 written exam

**Exercise 1**

Given the system described by the difference equation

$$4y(n-2) - 13y(n-1) + 3y(n) = 2x(n-2) + x(n)$$

- [6] Determine the impulse response of the system, assuming it is stable
- [3] Assuming the system is causal, choose an input signal of minimum duration such that the corresponding response is bounded, and determine this response
- [3] Represent the system in direct form I *transposed*.

**Exercise 2**Given the sequence  $x(n) = [-1 \ 3 \ -3 \ 1 \ 0 \ 0 \ 0 \ 0]$  for  $0 \leq n < 8$  and null elsewhere,

- [6] determine its DFT  $X(k)$  on  $N = 8$  points
- [3] compute the circular convolution - over 4 points - with the sequence  $h(n) = [1 \ 1 \ 1]$
- [3] assuming to interpret the sequence as the impulse response of a FIR filter, determine which is the type of filter (low pass, high pass, stop band, band pass) and why.

**Exercise 3**

[6] Determine the order of a Chebyshev filter with the following specifications:

- Clock frequency  $f_s = 24\text{kHz}$
- Passband limit frequency  $f_1 = 1.5\text{kHz}$
- Maximum passband attenuation 1dB
- Stopband limit frequency  $f_2 = 2\text{kHz}$
- Minimum stopband attenuation 40dB

Use the bilinear transform method with  $T = 1$ .