Practical works – n$^o$2

*Systems*

• **Reminder 1** Considering a sin function $x(t) = sin(2\pi ft)$ with `f= 1Hz`, when sampled with the sampling frequency $f_s$ `= 20` is equal to $x[n] = sin(2\pi \frac{f}{f_s} n)$. Plot both sin functions.

• **Exercise 1** – *Causality*

**1.1** Considering the system defined by the equation $y_k = (x_k + x_{k+1})/2$, check its causality property by examining the response to the signal $H(k-4)$ or `step(4,N)`. When plotting, include the abscissa range $[1 : N]$.

**1.2** Propose a modification to obtain a causal version and comment your observations.

• **Exercise 2** – *Stability*

**2.1** Program the primitive (accumulator) operator `prim(f)` applied on the signal `f` of length `N`. The value of the vector returned by `prim` at the index `k` will correspond to $\texttt{F}_\texttt{k}$ with $\texttt{k} \leq \texttt{N}$. Note $F_k = \sum_{q=-\infty}^{k} f_k$. Discuss on the result of the primitive operator applied to the signal $H(k-4)$. Is the primitive operator stable ?

**2.2** What is the impulse response of the primitive operator (in the discrete domain) ?

**2.3** Test the stability of the system defined by the equation: $y_k = x_k + 2y_{k-1}$. Plot the impulse response.

**2.4** Test the stability of the system defined by the equation: $y_k = x_k + y_{k-1}/3$. Plot the impulse response.

Comments your observations.

• **Exercise 3** – *Invariance and linearity*

**3.1** Define the following signals: $\texttt{x}_\texttt{a} = [\texttt{0 0 0 0 1 2 3 4 5 0 0 0 0 0 0 0 0 0 0}]$; $\texttt{x}_\texttt{b} = [\texttt{0 0 0 0 0 0 0 0 0 4 3 2 1 0 0 0 0 0 0}]$;. Compute the responses $y_a$, $y_b$ according to the equation $y = 3x_{k-1} - 2x_k + x_{k+1}$

**3.2** Prove the system defined by the previous equation is linear (and invariant).

**3.3** Propose a nonlinear/noninvariant system.