# Signals and Systems
# Lab Experience Session 2

## Exercise 1

Write a code (Matlab or Python) that computes the convolution between two signals $x[n]$ and $y[n]$:

a) Applying the definition formula: $z[n] = x[n] * y[n]$

b) Using the matrix computation: $\mathbf{z} = \mathbf{M}_y \mathbf{x}$

c) Verify the obtained results for the convolution using the built-in function: Matlab's `conv` function or Python's `numpy.convolve`.

The two signals are defined as follows:

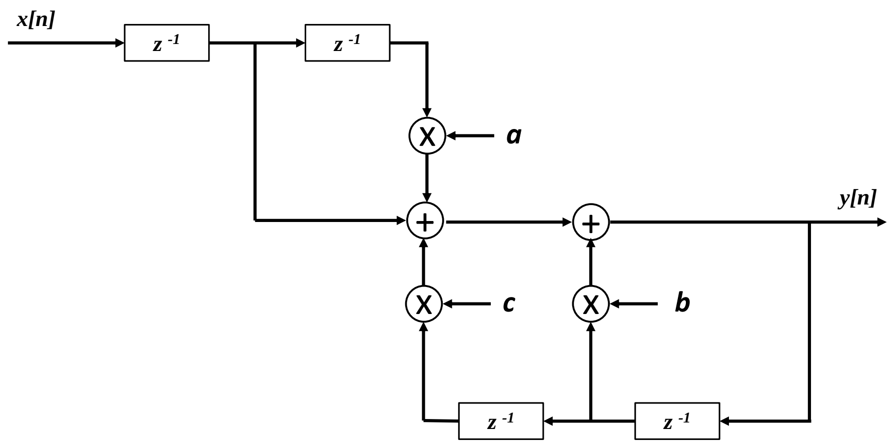
- $x[n] = Aa^n u[n]$, where $n \in ]-\infty, \infty[$, $A = 4$ and $a = -3/4$
- $y[n] = B \cdot r_{10}[n-5]$, where $B = 2$

*Required outputs*:

- Plot the signals and the result of the convolution;
- Compare the results obtained with the different convolution implementations;
- What is the extension of the convolution?

# Exercise 2

Consider the block diagram of the following LTI system:




*Required outputs*

- Find the transfer function in the Z domain;
- Write the difference equation;
- Given $a = 2$, $b = 3/5$ and $c = 1/9$, determine the zeros, the poles and the region of convergence (ROC) of the LTI system;
- Determine the impulse response analytically and verify if it is correct through a script;
- Considering the input signal $x[n] = (1/a)^n u[n]$, compute the output $y[n]$ both analytically using the inverse Z transform and using a script. For $a$ you can assume the same value defined above. Plot $x[n]$, $y[n]$ and the impulse response $h[n]$.

# Exercise 3

Consider the following difference equation $y[n] = k_1 x[n] + k_2 x[n-1] + k_3 x[n-2]$, with $k_1 = 1/4$, $k_2 = 3/4$ and $k_2 = -3/4$.

*Required outputs*

- Draw the block diagram and determine the transfer function in the Z domain;
- Determine the zeros and the poles;
- Determine the impulse response both analytically and using a script;
- Compute the output $y[n]$ assuming at the input the signal $x[n] = r_5[n-3]$ and verify the result using a script. Then plot $x[n]$, $y[n]$ and the impulse response $h[n]$.