Objectives

- To appreciate Impulse response of a filter as an operator
- To be able to write down convolution as a matrix operation for 1D signals

Assignments

[**S1.A.1**] Consider the sequence $x[n],\ 0 \leq n < 8$ given as an input to the 4 tap LTI filter with impulse response given by $h[k],\ 0 \leq k \leq 3$. Write down the expression for $y[n] = h[n] * x[n]$, where $*$ represents the convolution.

[**S1.A.2**] For the above exercise, write the expression of convolution as a matrix operation. Construct vector $x = [x[0]\ x[1]\ \ldots\ x[7]]^T$ and matrix H corresponding to the impulse response to generate output vector $y = [y[0]\ y[1]\ \ldots\ y[?]]^T$. Assuming initial values $x[-n] = 0, \forall n > 0$.

$$y = Hx \tag{1}$$

[**S1.A.3**] What is a circular convolution for LTI systems? How would you write the matrix equivalent of such convolution? Correlate it with the circulant matrices. What happens if we multiply a 4×4 circulant matrix with the 4×4 DFT matrix?

[**S1.A.4**] Consider the sequence $x[n] = \{1,\ 2,\ 1,\ -1,\ -2,\ -1,\ 1,\ 2\}$ and the impulse response of a filter $h[n] = \{1,\ -1\}$. Compute $y = x * h$. Using DFT perform the same as follows $y = F^{-1}(F(x).F(y))$. Compare the resulting y's. You need to carry out the calculations manually. Use matlab to check your answers.