CORRECTION OF TUTOPRIAL N°3

EXERCISE N°1

The transfer function of a given digital filter is given by :

$$H(f) = \sum_{k=0}^{N-1} h(kT_e) e^{-j2\pi f k T_e}$$

In general we consider the normalized frequency relative to the sampling frequency : $f_n = \dfrac{f}{F_e}$. When we consider the frequency 0 and 0.5, we talk about the normalized frequency.

$$H(f_n) = \sum_{k=0}^{N-1} h_k e^{-j2\pi f_n k}$$

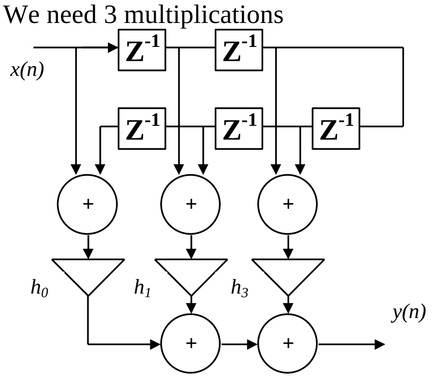
$$H(0) = \sum_{k=0}^{N-1} h_k = 2$$

$$H(0.5) = \sum_{k=0}^{N-1} h_k e^{-jk\pi}$$
$$= h_0 - h_1 + h_2 - h_3 + h_4 - h_5 = 0$$

After changing the sign of odd index coefficients :

$$H^{'}(0.5) = \sum_{k=0}^{N-1} h_k e^{-jk\pi}$$
$$= h_0 - (-h_1) + h_2 - (-h_3) + h_4 - (-h_5) = 2$$

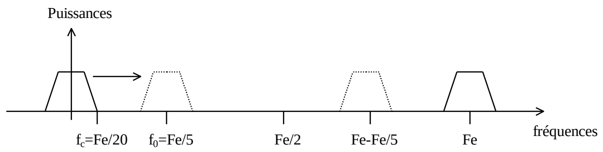
We need 3 multiplications



EXERCISE N°2

The multiplication in temporal domain is equivalent to a convolution operation in the frequency domain by $\delta(f + f_0)$ et $\delta(f - f_0)$

The low pass narrowband filter becomes a pass band filter around the frequency f_0



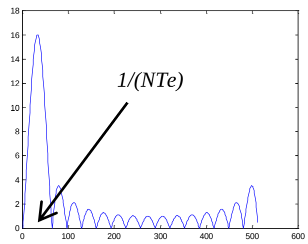
EXERCISE N°3

For each given real input $x(n)$, the computation of the filter output $y(n)$ requires 2 additions and two multiplications. By a confusion of the addition and the multiplication oeprations, the considered filter requires without any parallelisme process of theses operations, at minimum 40 Mops.

EXERCISE N°4

1) yes, it is the first output spectral component at frequency 0 of the signal FFT $\{x(n), x(n-1), \ldots x(n-63)\}$

2) cf Tutorial n°2 $\left| \dfrac{\sin \pi f N T_e}{N \sin \pi f T_e} \right|$



3) Yes, the same FFT but at the second output spectral components.

4) We compute an FFT 64 at each Te, i.e., with a sliding window of 64 values which shifts at each clock count.