Lectures for semester 1
Course Module : Digital Signal Processing
End course exam, December 19th 2014
1.5 hour, documents and calculators allowed
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I. The exponential signal, defined as
$x_a(t) = e^{-t}$, if t is positive or zero,
$x_a(t) = 0$, if t is strictly negative,
is sampled at the rate $F_s = 20$ samples per second, and a block of N =64 samples is used to calculate the spectrum.

a) Draw the signal $x_a(t)$ versus time
b) Calculate and draw versus frequency F the modulus of Fourier Transform $X_a(F)$ of $x_a(t)$.
c) Give the sampled signal x(n) as a series indexed by n.
d) Give the analytical expression of X(k), the discrete Fourier transform of x(n). It is not required to calculate X(k), but be aware in your relation with the different parameters: Fs, k, n and N…
e) Why is it interesting to choose N = 64? If N was initially equal to 60, how can we get 4 more samples to benefit from this interesting feature?

II. The first five points of DFT X(k) of a real-valued sequence x(n) of 8 samples are:
0.25; 0.125 – j 0.3018; 0; 0.125 – j 0.0518; 0; …
Determine the remaining three points.
Indication: Remember that:

$$X(k) = \sum_{n=-p}^{-p+N-1} x(n).e^{-2ik\pi\frac{n}{N}}$$

And take p= 4. Then, because x(n) is real-valued, use the symmetry of real part of X(k) from one hand, then of the imaginary part from the another one.

III. Calculate the FFT of the signal:
x(n) = { 1; 0; 0; -1; 1; -1; 0; 0 }.
And sketch its magnitude and phase.