L.EEC025 - FUNDAMENTALS OF SIGNAL PROCESSING

Academic year 2022-2023, week 3
TP (Recitation) problems

Topics: Frequency response of an LTI system, DTFT properties

Problem 1

A discrete system is described by the difference equation $y[n]=\frac{1}{5}\sum_{k=0}^{k=4}x[n-k]$ and it is admitted that the system starts from rest.

Create a .m Matlab command file that implements the following operations:

- creates a line vector h consisting of the impulse response of the system and represents it graphically (using the stem command), adding also a title and labels to the XX and YY axes,

- finds and represents in figure 2 the absolute value of the frequency response of the system in the frequency range 0-2π, and using N=512 points for the representation (in order to facilitate the readability of the XX axis, normalize its representation by π),

- finds and represents in figure 3 the phase response of the system in the frequency range 0-2π, and using N=512 points for the representation (in order to facilitate the readability of the XX axis, normalize its representation by π).

Problem 2

An averaging filter has the following difference equation:

$$y[n]=\frac{1}{5}(x[n]+x[n-1]+x[n-2]+x[n-3]+x[n-4]).$$

a) Find its impulse response, $h[n]$.

b) Find its frequency response, $H(e^{j\omega})$, and represent its absolute value and phase.

Problem 3

Consider that $x[n]$ is a real-valued and causal discrete-time signal, and its Fourier transform is $X(e^{j\omega})$. If $X_R(e^{j\omega})=1+\cos(\omega)$ is the real part of $X(e^{j\omega})$, find $X_I(e^{j\omega})$, the imaginary part of $X(e^{j\omega})$.