<u>**Due Date**: 10 October 2014, Friday (10:30).</u>

Homework 1

1) Let $x_1[n]=\cos(\omega_1 n)$ and $x_2[n]=\cos(\omega_2 n)$. Find two "frequencies" ω_1 and ω_2 such that $\omega_1 \neq \omega_2 + k2\pi$ for any integer *k*, and $x_1[n]$ and $x_2[n]$ are both periodic with fundamental period *N*=13.

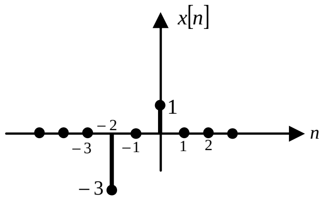
2) A linear, time invariant and causal system is described by the following linear constant coefficient difference equation (LCCDE),

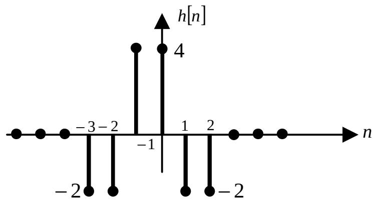
$$y[n]-a^2 y[n-2]=x[n]$$

a) Find the condition on a for the stability of this system.

b) Find the impulse response $h[n]$.

3) The impulse response and the input of an LTI system are given. Find and plot the output signal, $y[n]$.





4) The input-output relationship of a discrete-time system is described by

$$y[n]=x[n]+\frac{1}{2}x[n+1]-6x[n-9]+\delta[n-1] \qquad (\delta[n]\text{: unit sample sequence})$$

a) Is this a linear system? Why?
b) Is this a time-invariant system? Why?

5) Consider $x[n] = \delta[n-1] - \delta[n-5]$; let its DTFT be expressed as $X(e^{j\omega}) = A(\omega)\, e^{jB(\omega)}$.

Find the <u>real-valued</u> functions $A(\omega)$ and $B(\omega)$ in their <u>simplest</u> forms.

6) A real-valued sequence, $x[n]$, and its DTFT, $X(e^{j\omega})$, are known. $V(e^{j\omega}) = \mathrm{Re}\{X(e^{j\omega})\}$, is the real part of $X(e^{j\omega})$. Find $v[n]$ in terms of $x[n]$.

7) The values of $x[n]$ at n = -2,-1,0,1,2 are given as $x[n]=[-1 \;\; 2 \;\; \underset{\substack{\uparrow \\ n=0}}{7} \;\; 2 \;\; -1]$.

Assume that the DTFT of $x[n]$ is equal to $X(e^{j\omega})$. Find the following:

a) $X(e^{j0})$ **b)** Phase of $X(e^{j\omega})$, $\angle X(e^{j\omega})$ **c)** $\int_{-\pi}^{\pi} X(e^{j\omega})\,d\omega$ **d)** $X(e^{j\pi})$ **e)** $\int_{-\pi}^{\pi} \left|X(e^{j\omega})\right|^2 d\omega$

8) Find DTFT of the sequence $x[n]= n\, a^{n-3}\, u[n-3]$.

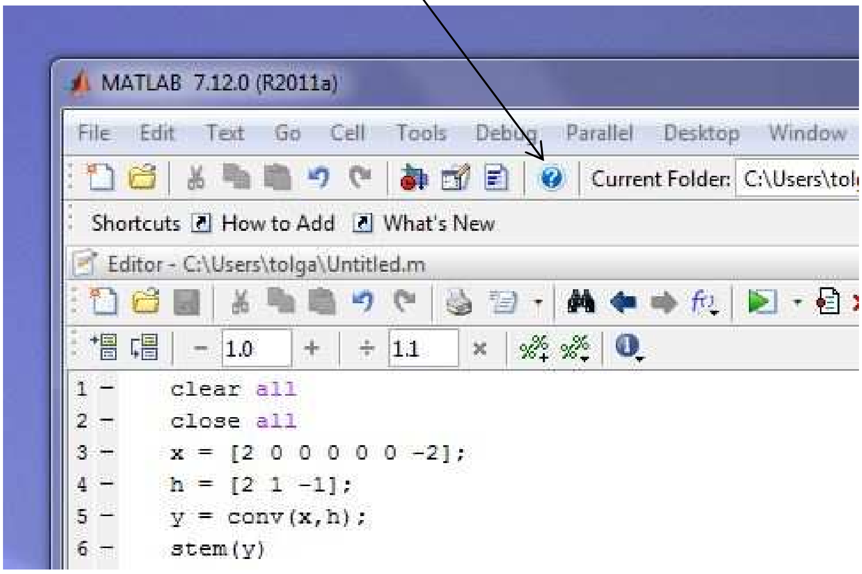
9) A real LTI system has the following input and output, $e^{j2\pi n/8} \longrightarrow \boxed{h[n]} \longrightarrow 2e^{-j2\pi/3}\, e^{j2\pi n/8}$

a) Find the system output for the input $e^{-j2\pi n/8}$

b) Find the system output, when the input sequence is $\cos(2\pi n/8+2\pi/5)$.

10) Type "help conv" in MATLAB command window to read about the command.

You can find more by visiting the "conv" page in the help menu.



a) Let $x[n]$={ 1 2 3 4 5 6 7 6 5 4 3 2 1} in n=[-3:9].

n=0

Let $h[n]$=1/5*[1 1 1 1 1] in n=[0:4]. Convolve $h[n]$ with $x[n]$. Let $r[n]$=conv($h[n]$,x[n]). Plot the output sequence r[n]. Comment on the smoothing effect of the filter $h[n]$. Plot abs($X(e^{jw})$) and abs($R(e^{jw})$). Comment on the differences of these signals in the frequency domain.

b) Let N be an integer. Apply Fourier transformations to find the output of the same system in part-a, by using z=ifft(fft(x,N).*fft(h,N)) command in MATLAB and compare $z[n]$ with $r[n]$ for different values of N. Determine the value of N, where r[n]=z[n]. Is this value unique?