BIRZEIT UNIVERSITY

Faculty of Engineering

Electrical and Computer Engineering Department

Digital Signal Processing, ENCS 4310

Suggested Problems on Chapter Two

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Problem #1:

a) For what values of ω is the signal $x[n] = \cos(n\omega)$ periodic with period 8.

b) Consider the following discrete-time signal $x[n]$

$$x[n] = 2\cos\left(\frac{\pi n}{2}\right) + 2\sin\left(\frac{\pi n}{5}\right) + 3\cos\left(\frac{\pi n}{4} - \frac{\pi}{6}\right)$$

1. Determine whether the following discrete-time signal $x[n]$ is periodic or a periodic? If period, find the fundamental period and the fundamental frequency
2. Find the output $y[n]$ for LTI system with the frequency response $H(e^{j\omega}) = (1 + 2\cos(2\omega))e^{-j2\omega}$

Problem #2:

Determine the following properties (linearity, time invariant, causality, stability, and invertibility) for the following systems

a) $y[n] = 30\,x[n] - 15\,x[n-1]$
b) $y[n] = n\,x[n]$
c) $y[n] = \sin(x[n])$
d) $y[n] = 2x[n] - x[n-1] + x[n+4] + 2\,y[n-1]$
e) $y[n] = \sum_{k=-\infty}^{n} x[k] + u[n-1]$

Problem #3:

(a) Apply one of the methods you have learnt to compute discrete-time convolution of the following two finiteduration signals:

h(n) ={ <u>0.25</u>, 0.25, 0.25, 0.25}, and x(n) = {<u>5</u>,0,2,0,-1,0,1,0, 2,0,4,0,6,0}, noting that every other sample of x(n) is zero. Suggest a potential DSP application of this particular convolution?

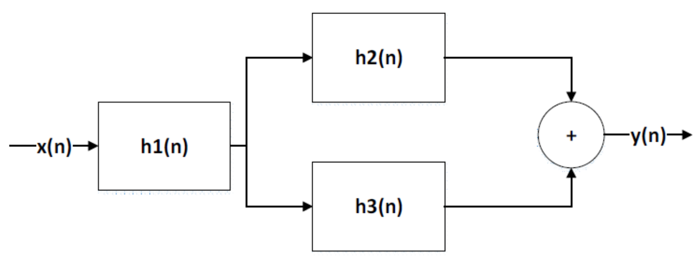
Problem#4: A digital filter has the impulse response $h[n] = [-1\ \underline{0.5}\ 0\ 2]$ and is implemented at a sampling frequency of 8 KHz, an input signal $x[n] = [\ \underline{0.5}\ \ 1\ 0]$ is sent through the filter, given the output y[n]. Note, the underline sample is the sample at $n = 0$.

a. Find the output $y[n]$.
b. Find the frequency response of this filter, i.e, $H(e^{j\omega})$.
c. Find the output response of this filter when input is a cosine signal with unity amplitude and frequency 1KHz.

Problem #5:

A signal $x[n]$ has the Fourier transform $X(e^{j\omega}) = \frac{1}{(1-0.5e^{-j\omega})}$, determine the Fourier Transform of $x_1[n] = e^{-j3\pi n}x(n-4)$.

Problem #6: Consider the system in the following system



$h_1[n] = \delta[n-2], h_2[n] = \left(\frac{2}{5}\right)^n u[n]$, and $h_3[n] = 2\delta[n]$.

a) Find the expression of the total impulse response, $h[n]$
b) Find the frequency response of the whole system, $H(e^{j\omega})$
c) Check if this system stable and/ or causal? Justify your answer.
d) Use the frequency response expression in part (b) to write the difference equation that characterize this
system.

Problem #7: Consider the following sequences

$x[n] = [1\ 3-2\ 4]$ and $y[n] = [2-1\ 4-2]$

a) Determine the autocorrelation $R_{xx}(k)$, and $R_{yy}(k)$
b) Determine the cross-correlation $R_{xy}(k)$
c) Determine the Energy for each signal
d) Determine the autocorrelation C_{xx}, and C_{xy}

Problem #8 (Matlab Assignment):

A. Consider the impulse response of digital filter is given by

h(n) =[0.25 0.25 0.25 0.25]

Write code matlab to recover samples of an audio signal. Use the following steps:

- Record your voice, say Good Morning.
- Read your recorded file using WAVREAD(.) command.
- Set everyother sample to zero to produce an array. Call this $x(n)$.
- Assume $x(n)$is the input of the proposed digital filter. Evaluate the output of this filter by using Convolution theorem between $x(n)$ and $h(n)$. Use CONV(.) command.
- Plot (or stem) a 20 samplessection of y(n) togetherwith the same 20 samplessection of x(n) and compare them.
- Submit the plot and Matlab code and any other observation.

B. Consider the following sequences
$x[n] = [1\ 3 - 2\ 4]$ and $y[n] = [2 - 1\ 4 - 2]$

Write a Matlab code to calculate the correlation coefficient between these two signals.

GOOD Luck