AMERICAN UNIVERSITY OF BEIRUT
Department of Electrical and Computer Engineering
EECE340 Signals and Systems -Summer 2011

Lecturer: Prof. Fadi N Karameh

Quiz 2, July 28, 2011

Directions:

- Write down your name *in ink* below and your initials on all the pages. DO IT NOW!
- You have 1.5 hours to complete the quiz.
- Enter ALL your work and your answers on the answer booklet. You can use the back of these pages for scratch. I will ONLY grade the work you neatly transfer to the booklet.
- Answers must be explained or derived. DO NOT just write down an answer, unless otherwise indicated.
- It is a good idea to read the whole test before you begin. Problems are divided into several parts with percentages indicated. You might be able to solve different parts independently.
- DO NOT talk to any of your colleagues under any circumstances. You will be penalized without warning.

YOUR NAME HERE:

PROBLEM 1 (32%)

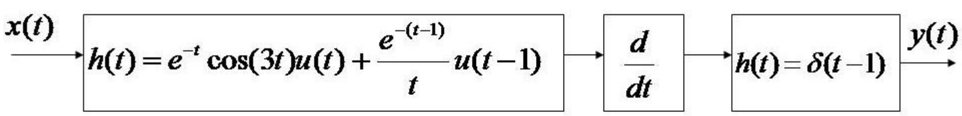
DIFFERENT PARTS OF THIS PROBLEM ARE INDEPENDENT

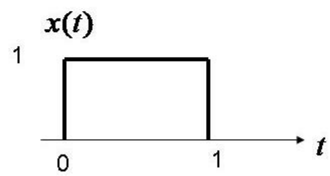
a) A CT LTI system with input $x(t)$ and output $y(t)$is described by the following relationship

$$y(t) = \int_{-\infty}^{t} e^{-4(t-\lambda)} x(\lambda - 1) d\lambda$$

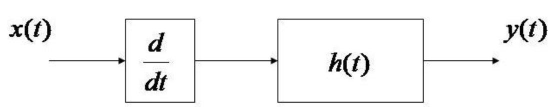
- Is this system causal? explain.
- Is this system stable? explain.
- If an input of $x(t) = u(t)$ is applied to this system find $y(t = t_o)$ when $t_o = \frac{1}{2}$.

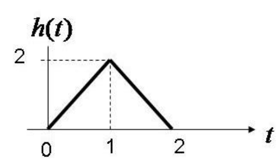
b) Consider the CT causal LTI system shown in figure below. Find the output $y(t)$ for the input$x(t)$ shown.



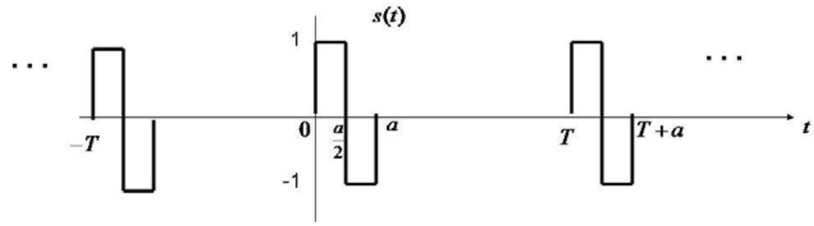


c) Consider the CT causal LTI system shown in figure below. Find the ENERGY in the output signal $y(t)$ for the input$x(t) = 2 + \cos(4\pi t)$.





d) Find the CTFT of the following signal. Assume a= T/4



PROBLEM 2 (10%)

Consider a causal unit sample response $h[n]$.

a) What can you say about the Z- transform of $h[n]$ when $z \to +\infty$?

b) Consider the following transfer function

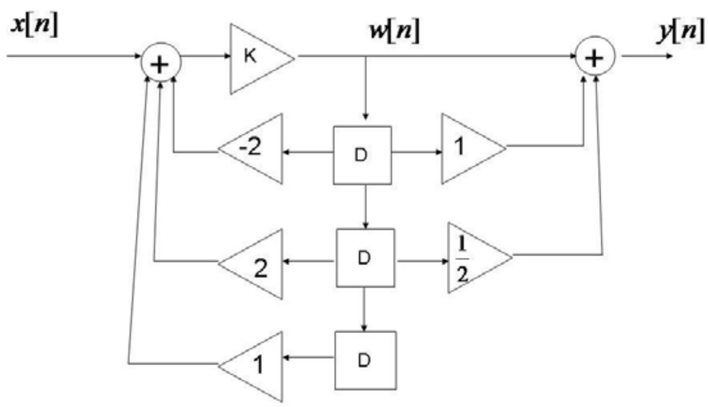
$$H(z) = \frac{\left(z - \frac{1}{3}\right)^4}{\left(z - \frac{1}{2}\right)^3}$$

i- Find the Region of convergence of $H(z)$ if the corresponding system is stable.

ii- based on part a), can this system be causal?

PROBLEM 3 (15%)

Consider the block-diagram representation of a DT causal LTI system shown below. D represents the unit delay operator.



a) Find the transfer function between the input $x[n]$ and output $y[n]$ denoted by $H(z)$.

b) Find the constant gain K such that the system has one of its pole at $z = -\frac{1}{2}$.

c) Is thus system stable? explain.

PROBLEM 4 (23%)

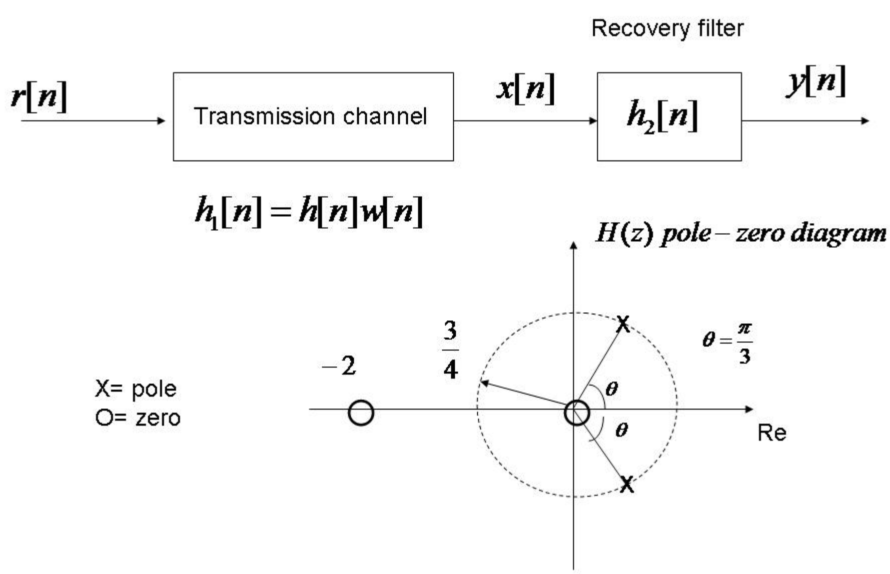
Consider the problem of transmitting a signal $r[n]$ through some transmission channel. The channel is assumed to be a causal LTI CT system which can be described by

(i) A transfer function $H(z)$ whose pole-zero diagram is as shown in the figure (2 poles and 2 zeros).

(ii) A multiplicative high frequency signal $w[n] = (-1)^n$, $\forall n$

such that the over all model of the channel is given by

$$h_1[n] = h[n]w[n] = (-1)^n h[n]$$



In this problem you will attempt to design a causal LTI "recovery" filter $h_2[n]$ which, when applied to the received signal $x[n]$ will recover the input signal $r[n]$ at its output.

a) Find the transfer function of the overall channel $H_1(z)$

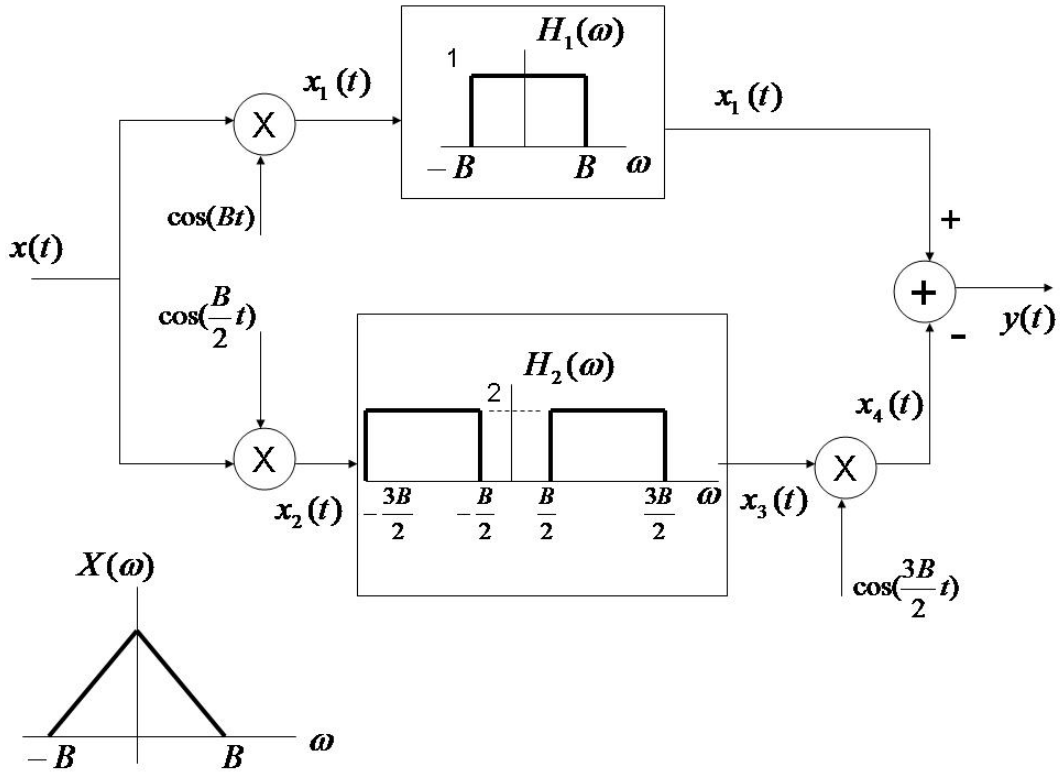
b) Find the transfer function of the recovery filter $H_2(z)$.

c) Is the design of $h_2[n]$ implementable, explain?

d) Now assume that the multiplicative signal $w[n]$ is actually of the form $w[n] = (a)^n$, $\forall n$. Is there a value (or range) of a such that you can recover the signal $r[n]$? If so, find this a.

PROBLEM 5 (20 %)

Consider the AM modulation scheme shown in figure below. The input signal $x(t)$ is bandlimited to B rad/sec and assumed to have the CTFT $X(w)$ shown.



a) Sketch the Fourier transform of the various signals $x_1(t)$ though $x_4(t)$ and $y(t)$

b) Describe the function of this system. Does it have any advantages over regular DSB-AM?

c) Devise a demodulating system to recover the signal $x(t)$ from $y(t)$. You can use multipliers, oscillators, gains and filters.