In the Name of God

Communication Systems (25751-1)
Problem Set 02

Department of Electrical Engineering
Sharif University of Technology
Fall Semester 1398-99
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Due on ////////////////// at 7:30 a.m.

1 The Fourier Transform

Find the Fourier transform of the following signals:

1. $f(x)$ (plotted in figure 1)

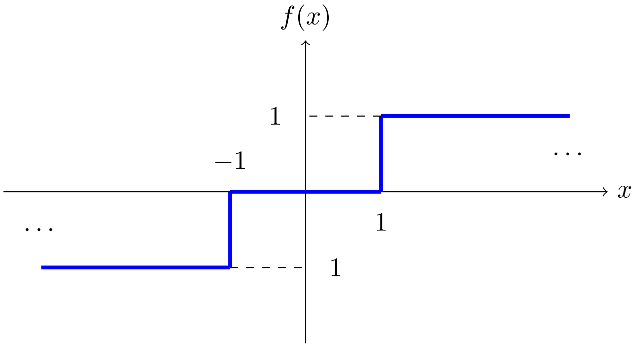

Figure 1

2. $f(t) = \sin(2\pi|t|)$

2 The Hilbert Transform

Find the Hilbert transform of following signals:

1. $x_1(t) = \sin(2\pi 6 f_c t)$
2. $x_2(t) = \frac{1}{a^2+t^2}$
3. $x_3(t) = A\Pi(\frac{t}{T}) = A[u(t+\frac{T}{2}) - u(t-\frac{T}{2})]$
4. $x_4(t) = \mathrm{sinc}(2Wt)$

3 Tapped Delay Equalizer

Design a 3 - taped delay line equalizer for the channel

$$H_c(f) = \exp[-j(2\pi fT - \alpha \sin(2\pi fT))]$$

Assuming that $\alpha = 0.1$, plot the channel and equalizer transfer function.

4 Even-Odd Decomposition

Suppose an LTI system with impulse response $h(t)$ and transfer function $H(f)$. We assume that this filter is physically realizable , then its impulse response is real and has the causal property. [$\forall t : h(t) \in \mathbb{R}$ and $h(t) = 0$ for $t < 0$]

1. We define even part and odd part of $h(t)$ as $h_e(t) = \frac{h(t)+h(-t)}{2}$, $h_o(t) = \frac{h(t)-h(-t)}{2}$
   Show that in this case, we can write:

$$h(t) = 2h_e(t)u(t)$$

   (Assume that $u(0) = \frac{1}{2}$)
2. Write $h_e(t)$ in terms of $H_e(f)$, the Fourier Transform of $h_e(t)$
3. Write $h(t)$ in terms of $H_e(f)$
4. Write $h_o(t)$ in terms of $H_e(f)$
5. Write $H_o(f)$ in terms of $H_e(f)$
6. Show that $H_o(f) = \hat{H}_e(f)$ [It means that $H_o(f) = (\frac{1}{\pi f}) * H_e(f)$]

5 Attenuation and Amplification

A 900 km repeater system consists of m identical fiber optic cable sections with attenuation $\alpha = 0.24dB/km$ and m identical amplifiers. Find the required number of sections and gain per amplifier so that $P_{out} = P_{in} = 2.5dBm$ and the input power to each amplifier is at least $30\mu W$.

6 Channel Bandwidth

In an optical fiber communication system, the band from $1.4nm$ to $1.65nm$ can be used. Find out how much bandwidth is available in this band. (Assume speed of light in fiber is $2108m/s$). If transmission of an analog video signal requires $4.2MHz$ of bandwidth, how many video channels can be transmitted in this band?

7 Bessel Filters

(Computer Assignment) Use MATLAB to do the following:

1. Plot the frequency response and group delay response of a low pass Bessel filter of degree $N = 1$, Passband gain=20 and 3-dB frequency of 4000 Hz.

2. Find the ratio of -60dB to -6 dB bandwidth
3. If we insist that the deviation from the requirements for distortion-less transmission are to be no greater than 2 percent, determine the maximum bandwidth normalized to 3-dB bandwidth, that may be handled by this filter (On the basis of the magnitude of the frequency transfer function)
4. Repeat the above for $N = 12$ and $N = 18$

8 Tapped Delay Equalizer

(Computer Assignment) A 4-tap equalizer has these tap values: $\{a_0, a_1, a_2, a_3\}$ (a_0 is the tap for zero delay, a_3 is the tap for $3T$ delay). Using a minimum of 200 points, plot the magnitude of the transfer function and its phase assuming $T = 1$ for each of these cases:

1. $\{a_0, a_1, a_2, a_3\} = \{-1,\ +1,\ -1,\ +1\}$
2. $\{a_0, a_1, a_2, a_3\} = \{-2,\ +1,\ +2,\ -2\}$
3. $\{a_0, a_1, a_2, a_3\} = \{+1,\ -3,\ -1,\ +3\}$
4. $\{a_0, a_1, a_2, a_3\} = \{+2,\ -3,\ +2,\ -2\}$