ECE 310 **University of Illinois at Urbana-Champaign** **Fall 2015**

Profs. Bresler & Radhakrishnan **Homework 11** **Due: Friday, Nov 20**

Reading: Chapter 13

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1. Given an input $x[n]$, let $v[n]$ be the output of a upsampler by an integer factor L, and $w[n]$ be the output of a downsampler by an integer factor M. That is, $w[n] = x[nM]$, and

$$v[n] = \begin{cases} x[k] & n = Lk \\ 0 & otherwise \end{cases}$$

Given that,

$$X_d(\omega) = \begin{cases} 1 - \frac{4|\omega|}{\pi} & |\omega| \leq \pi/4 \\ 0 & \pi/4 \leq |\omega| \leq \pi \end{cases}$$

(a) Sketch $V_d(\omega)$ for $L = 2$.

(b) Sketch $V_d(\omega)$ for $L = 3$.

(c) Sketch $W_d(\omega)$ for $D = 2$.

(d) Sketch $W_d(\omega)$ for $D = 4$.

2. Consider the system illustrated in Fig. 1. The frequency response $H_d(\omega)$ is given by,

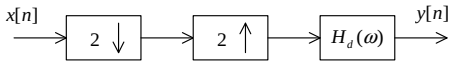

Figure 1: System for Problem 3

$$H_d(\omega) = \begin{cases} 1 & |\omega| \leq \pi/2 \\ 0 & otherwise \end{cases}$$

Find the output $y[n]$ for the following input sequences,

(a) $x[n] = cos(\frac{\pi}{4}n)$

(b) $x[n] = cos(\frac{3\pi}{4}n)$

(c) $x[n] = \frac{sin(\frac{\pi n}{8})}{\pi n}$

3. A compact disc player reproduces an audio signal having a 20 kHz bandwidth from samples collected at the rate of 44,100 samples per second. If the D/A converter uses oversampling by a factor of L, then for each value of L below, determine the maximum allowed width of the transition band of the required analog filter, such as might be used after a zero-order hold (ZOH) interpolator, for: (a) $L = 1$, i.e., a standard D/A; (b) $L = 2$ and (c) $L = 4$