ECE161A
Discrete Time Signal Processing

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Problem Set #6
Due: Tuesday, Nov 20, 2007

1. Given a system with impulse response

$$h[n] = \sum_{k=-\infty}^{\infty} \Big(2\delta[n-8k] + \sqrt{(}2)\delta[n-1-8k] - \sqrt{(}2)\delta[n-3-8k] - 2\delta[n-4-8k] - \sqrt{(}2)\delta[n-5-8k] + \sqrt{(}2)\delta[n-7-8k] \Big).$$

   (a) Find $H(\Omega)$, the DTFT of $h[n]$.

   (b) Find the phase of $H(\Omega)$.

2. Consider a finite length signal $x[n]$ with length 2, whose DTFT is given by $X(\Omega)$. For a fix number N ($N \geq 2$), assume that $\hat{X}_N$ is the sampled version of $X(\Omega)$ at sampling rate $\frac{2\pi}{N}$.

$$\hat{X}_N(\Omega) = \sum_{k=-\infty}^{\infty} X(\frac{2\pi k}{N})\delta(\Omega - \frac{2\pi k}{N}).$$

   Now consider the inverse DTFT of $\hat{X}_N(k)$, which we call $\hat{x}[n]$. Show that

$$\hat{x}[0] = \frac{N}{2\pi} x[0]$$

3. Find the DTFT (using sampling theorem) of $\cos(3\pi n)$ and $\cos(3n)$.

4. Consider a filter whose frequency response is given as $\frac{\sin(2\Omega)}{\sin(\Omega)}$.

   a. Is this filter an FIR or IIR? If it is FIR, what is the length of its impulse response?

   b. What is the output of this filter when the input is $x[n] = cos[\frac{\pi}{3}n + \frac{1}{12}] + sin[\frac{\pi}{4}n + 2]$?