EE 521: Homework 6

1. Figure 1 shows an ideal discrete lowpass filter. The inverse discrete Fourier transform of the

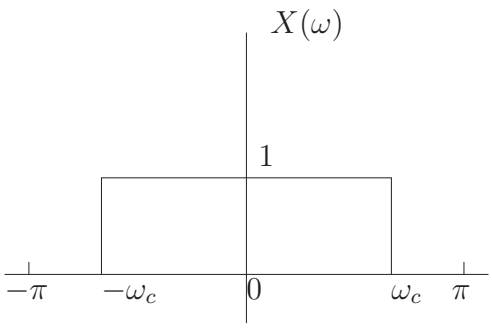

Figure 1: Ideal lowpass filter

above filter is given by

$$x(n) = \frac{\sin \omega_c n}{\pi n}, \quad -\infty < n < \infty \tag{1}$$

   (a) Generate $x(n)$ over the range of $-N$ to N for various values of N. For each value of N use `freqz` in MATLAB and plot the magnitude response.

   (b) Is there a value of N that will give you the ideal lowpass filter shown in Figure 1.

   (c) Multiply the sequence $x(n)$ by a hamming window and recompute the `freqz` and plot the result. How is that different from the first part.

2. What is the z-transform of a sequence of the form shown in the Eq. 1?

3. Given

$$X(z) = \frac{1}{1 - z^{-1}} \tag{2}$$

   (a) Compute the inverse z-transform of $X(z)$.

   (b) Compute and plot $X(\omega)$. Since $X(\omega)$ is ∞ at $\omega = 0$, replace that value with an impulse.

   (c) What can you say about the frequency content of a signal that has an abrupt change?

4. Given a sampling rate of 1kHz, design a digital oscillator.

   (a) Show the pole-zero locations.

   (b) Compute the transfer function $H(z)$.

   (c) Derive the impulse response $h(n)$.

   (d) Derive the difference equation.

   (e) what is the input to the difference equation that will result in an oscillator output.