ICE503 DSP-Homework#8

1. Compute the discrete Fourier transform (DFT) of each of the following finite-length sequences considered to be of length N (where N is even):

   (a) $x[n] = \begin{cases} 1, & n \text{ even}, \quad 0 \le n \le N-1 \\ 0, & n \text{ odd}, \quad 0 \le n \le N-1 \end{cases}$

   (b) $x[n] = \begin{cases} 1, & 0 \le n \le N/2-1 \\ 0, & N/2 \le n \le N-1 \end{cases}$

   (c) $x[n] = \begin{cases} \alpha^n, & 0 \le n \le N-1 \\ 0, & \text{otherwise} \end{cases}$

2. If figure are two systems consisting of a compressor and an expander.

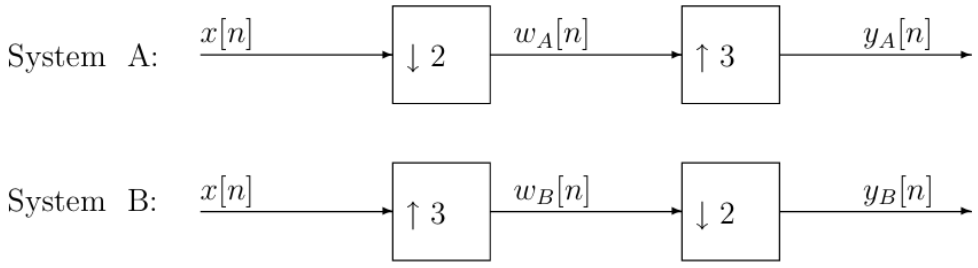

Figure 1-1

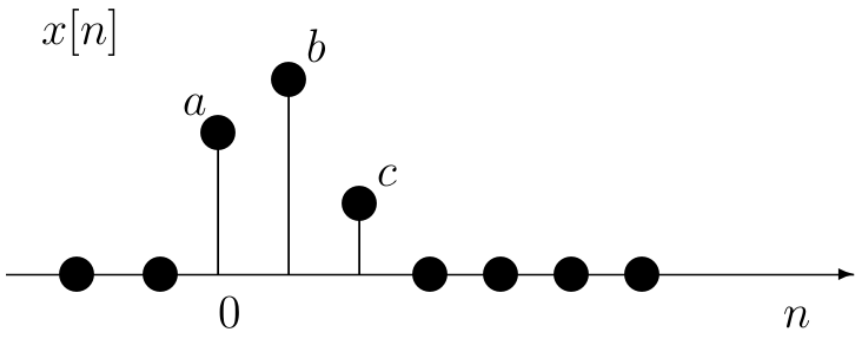

Figure 1-2

(a) For x[n] as shown in figure 1-2 sketch $y_A[n]$ and $y_B[n]$ (assume $x[n] = 0$ outside the interval shown).

(b) $X(e^{j\omega})$ denotes the Fourier transform for an arbitrary $x[n]$. Express $Y_B(e^{j\omega})$ in terms of $X(e^{j\omega})$.Your answer should be in the form of an equation, not a

sketch for a specific Fourier transform.

(c) For any arbitrary x[n], will $y_A[n] = y_B[n]$? If your answer is yes, algebraically justify your answer. If your answer is no, clearly explain or give a counterexample.

(MIT OperCoureseWare DSP 2004 Midterm Exam)

3. MATLAB simulation:

Generate a cosine wave for 1 second

$$x(t) = \cos(2\pi \times 10 \times t).$$

Then, sample the cosine wave $x(t)$ with 100Hz to obtain $x[n]$.

(a) Compute the DFT of $x[n]$ with DFT matrix to obtain $X[k]$.

(b) Compute the IDFT of $X[k]$ with DFT matrix to obtain $x[n]$.

(c) Compute the DFT of $x[n]$ with fft function to obtain $X[k]$.

(d) Compute the IDFT of $X[k]$ with ifft function to obtain $x[n]$.

(e) Use stem function to plot the amplitude of $X[k]$ and $x[n]$ for (a) ~ (d).