Homework 10

CSCI-UA.0480-005
Special Topics: Electrical Engineering for Computer Scientists
Prof. Rappaport

Due: May 5, 2015 @ 9:30 AM

1. Refer to the sinusoid in the Figure 1 below for each parts a, b, c, and d to follow.

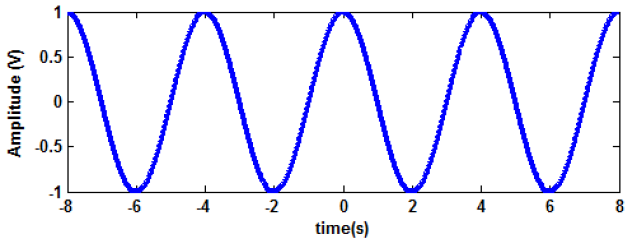

Figure 1

   a. Draw the discrete representation of the signal if the sampling frequency is $f_s = 1$ Hz. How many bits of resolution can we resolve with this sampling rate?
   b. Draw the discrete representation of the signal if the sampling frequency is $f_s = 2$ Hz. How many quantized levels can we determine with this sampling rate?
   c. What is the minimum frequency f_s we should sample at to be able to fully recover the original continuous time signal?
   d. If the signal in Figure 1 is sampled such that each sample is quantized into a finite value with quantization bins of 0.125 volts, how many bits are used to store each sample value.

2. Draw an example of each of the following signals and label all axes carefully:

   a. A continuous time signal that has average power and infinite energy.
   b. A discrete time signal that is anti-causal.
   c. $r[n-5]$ for all n.

3. Determine the following for a cosine wave and explain why:

   a. Is a cosine wave causal, non-causal, and/or anti-causal?

   b. Does a cosine wave have finite energy, infinite energy, and/or average power?

   c. Is a cosine wave stable or non-stable?

4. Graphically and numerically determine the convolution of $x_1[n] * x_2[n] = y[n]$, if $x_1 = x_2 = P_5[n]$. That is, graphically and numerically solve for $y[n]$.

5. A discrete-time system may be classified as follows:

   - causal or non-causal
   - linear or non-linear
   - time-invariant or time-varying

   Classify each of the following discrete-time systems.

   a. $y(n) = \cos(x(n))$

   b. $y(n) = x(n) + 2x(n-1) + 3x(n-2)$ **(hint: create a sample** $x(n)$**)**

6. A discrete-time system is described by the following expression:
   $y(n) = 2x(-n) - x(n-1)$, where x is the input signal, and y is the output signal.

   a. Sketch the output signal, y(n), produced by the 4-point input signal, x(n) illustrated below.

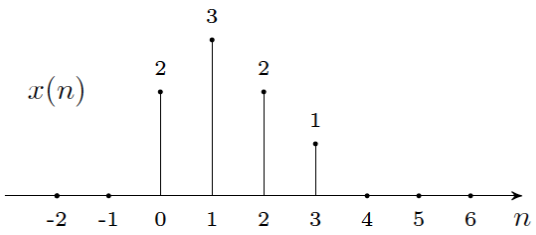

Figure 2

   b. Classify the system as:

      i. causal or non-causal

      ii. linear or non-linear

      iii. time-invariant or time-varying