Recitation 2 - EECS 451, Winter 2009

Jan 14, 2009

OUTLINE

- Review of Sampling
- Practise problems

Concepts

1. Sampling
   - Sampling Theorem
   - Ideal Sampling and reconstruction
   - Practical issues
   - Interpretation of aliasing in both frequency and time domain

Problems

1. A signal $x(t) = \cos(200\pi t)$ is sampled at a rate of ω_s and stored. Is it possible to reconstruct the original signal from the stored samples using an ideal low pass filter when
   (a) $f_s = 85\text{Hz}$
   (b) $f_s = 800\text{Hz}$
2. The following analog sinusoidal signal is sampled 400 times a second and each sample is quantized into 256 different voltage levels

$$x_a(t) = 2\cos(500\pi t) + 3\cos(300\pi t)$$

   (a) Determine the Nyquist sampling rate.
   (b) Determine the folding frequency.
   (c) Determine the frequencies in the resulting discrete-time signal $x(n)$.
   (d) What will be the signal reconstructed assuming an ideal D/A converter and neglecting the quantization effect?

3. A seismic signal with amplitude range $[-1, 1]$ volts is sampled and quantized with a 12 bit A/D converter before transmitting it over a communication channel which can support a maximum bit rate of 240 Kbits/sec. What is the maximum sampling frequency the system can support? What is the maximum frequency that can be present in the original seismic signal in order to avoid any loss of information?

4. A signal $x(t)$ when sampled at a rate $f_s = 1/T_s = \omega_s/2\pi$ produced the samples $\{x[nT_s]\}_{n=-\infty}^{\infty}$. Let $y(t)$ be a signal constructed from these samples, where

$$y(t) = \frac{\omega_c}{\pi} \sum_{n=-\infty}^{\infty} x[nT_s] sinc(\frac{\omega_c}{\pi}(t - nT_s))$$

How is $y(t)$ related to $x(t)$ when the frequency spectrum of $x(t)$ is as shown in the figure below with (i) $\omega_c = \omega_s/4$, (ii) $\omega_c = \omega_s$