MEEN 2210 Electromechanical Engineering Systems Spring 2011

Problem Set #1 Due Class Period # 3 January 26, 2011

1. A music signal is sampled at 44,100 samples per second for a duration of 30 minutes. How many numbers are needed to represent the music samples?

2. Suppose $s(t) = t^2 + 1$ and $T_s = 0.5$. Find and plot the values of the samples $s[n] = s(nT_s)$, n = -4, -3, -2, -1, 0, 1, 2, 3, 4.

3. Telephone speech is band-limited to approximately 3500 Hz. What is the minimum sampling rate that will avoid information loss for this signal?

4. The bandwidth of the audio signal broadcast on AM radio is 5 kHz. Commercial AM radio is currently analog. If AM radio were to go digital, what would be the minimum sampling rate needed for the audio signal?

5. Suppose $s(t) = \cos(4\pi t)$ and $T_s = 0.1$ sec. Find and plot the values $s[n] = s(nT_s)$, n = 0, 1, …, 10. When sampling with this period T_s, are you sampling above the Nyquist rate?

6. Given the signal $s(t) = \sin(100\pi t)$, plot its samples, assuming $T_s = 0.01$ sec. What has happened? Have you sampled above the Nyquist rate?

7. You are making a television show set in the 1970s. As part of the show, you are filming a phonograph changer playing a disco record. If your 30-frames-per-second video shows one revolution of the record every 54 frames, how many revolutions per minute do you think the record is spinning? Can you tell for sure?

8. Answer the following questions.
   a) How many different numbers can be represented by 10 bits?
   b) How many bits would be required to store the decimal number 100,000?
   c) Convert the positive integer 11011011_2 to decimal.
   d) Write the decimal integer 195 in binary form.
   e) Convert the positive fraction 10101.010_2 from binary to decimal.
   f) Write the decimal fraction 19.3125 in binary form.

9. Consider a decimal fraction having 6 digits to the left of the decimal point and 4 digits to the right. In binary notation, how many digits to the left and right of the binary point would be needed to store numbers covering the same range as that covered by the decimal representation?

10. The sampled signal $s[n] = 1.75 + 2\cos(0.6n)$ is quantized to the eight levels 0, 0.5, 1, 1.5, 2, 2.5, 3, and 3.5. Find and plot the original samples s[n] and their quantized values for n = 0, 1, 2, …, 12. Assign 3-bit binary values to the quantized samples.