Assignment 1

CN8811 Multimedia Processing and Digital Communications

(Chap1 and 2: signal/systems, A/D conversion)

1. A message signal is represented by $10\cos(100\pi t)$.

   (a) Determine the Nyquist rate of the sampled signal.

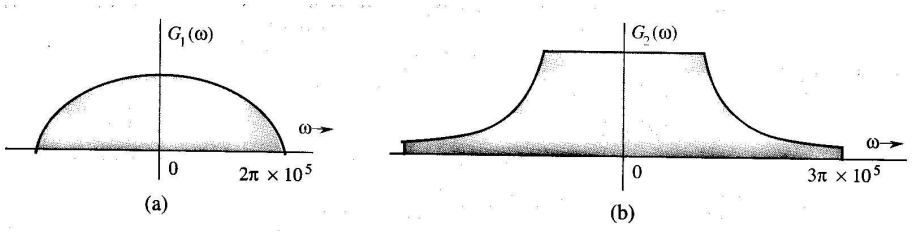
   (b) Show the amplitude spectrum of the signal sampled at Nyquist rate.

   (c) Show the amplitude spectrum of the signal sampled at two times the Nyquist rate

   (d) Show the amplitude spectrum of the signal sampled at 0.5 times the Nyquist rate.

   The frequency axes in the spectral plots should be clearly labelled.

2. The following figure shows Fourier spectra of signals $g_1(t)$ and $g_2(t)$. Determine the Nyquist interval and the sampling rate for signals $g_1(t)$,$g_2(t)$,$g_1^2(t)$,$g_2^2(t)$, and $g_1(t)g_2(t)$ (note $\omega = 2\pi f$).



3. A compact disc (CD) records audio signal digitally by using PCM. Assume the audio signal bandwidth to be 15 kHz.

   (a) What is the Nyquist rate?

   (b) If the Nyquist samples are quantized into $L = 65,536$ levels and then binary coded, determine the number of binary digits required to encode a sample.

   (c) Determine the number of binary digits per second (bit/s) required to encode the audio signal.

   (d) For practical reasons, signals are sampled at a rate well above the Nyquist rate. Practical CDs use 44,100 samples per second. If $L = 65,536$, determine the number of bits per second required to encode the signal.

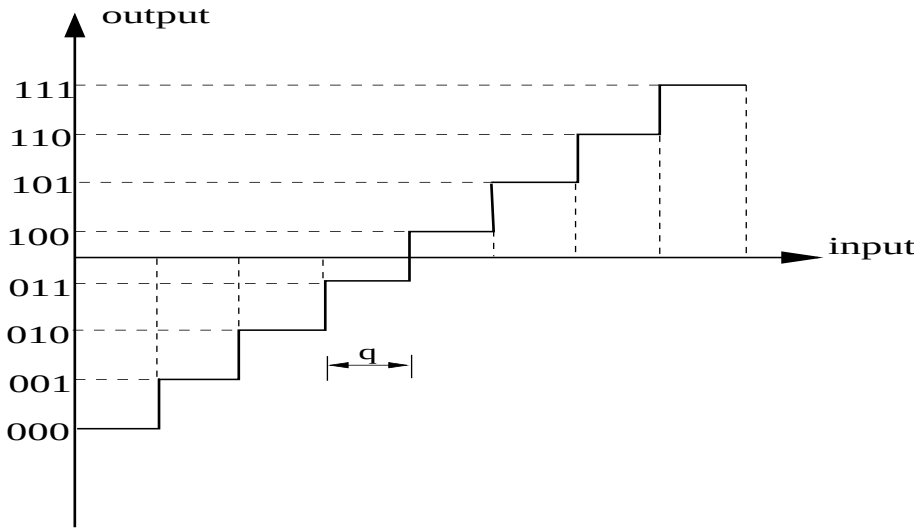
4. The signal is given as $y(t) = 2\sin(2\pi \times 10t) + 3\cos(2\pi \times 20t)$.

(a) Find the Nyquist sampling rate, f_N, of the signal $y(t)$.

(b) If $y(t)$ is sampled at $f_s = 100$ Hz, find the values of the first 5 samples sampled at $t = nT_s$ $(n = 0, 1, 2, 3, 4)$, where T_s is the sampling interval.

(c) If you are given that $y_{\max}(t) = 3$ and $y_{\min}(t) = -5$, and using the uniform quantizer shown below, find the quantization stepsize q, the corresponding quantization levels and the corresponding PCM code of the 5 samples in part (b).

(d) For the above quantizer, find the signal-to-quantization-noise ratio SNR.



5. Textbook: 2.1, 2,8, 2.9, 2.15, 2.16, 2.19