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Sheet 1 Revision

Problem#1

6.1-4 A signal $g(t) = \text{sinc}^2(5\pi t)$ is sampled (using uniformly spaced impulses) at a rate of: **(i)** 5 Hz; **(ii)** 10 Hz; **(iii)** 20 Hz. For each of the three case:

(a) Sketch the sampled signal.

(b) Sketch the spectrum of the sampled signal.

(c) Explain whether you can recover the signal $g(t)$ from the sampled signal.

(d) If the sampled signal is passed through an ideal low-pass filter of bandwidth 5 Hz, sketch the spectrum of the output signal.

Problem#2

6.1-5 Signals $g_1(t) = 10^4\text{rect}(10^4 t)$ and $g_2(t) = \delta(t)$ are applied at the inputs of ideal low-pass filters $H_1(\omega) = \text{rect}(\omega/40,000\pi)$ and $H_2(\omega) = \text{rect}(\omega/20,000\pi)$ (Fig. P6.1-5). The outputs $y_1(t)$ and $y_2(t)$ of these filters are multiplied to obtain the signal $y(t) = y_1(t)y_2(t)$. Find the Nyquist rate of $y_1(t)$, $y_2(t)$, and $y(t)$.

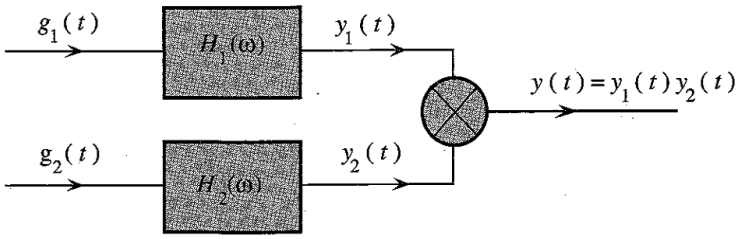

Figure P6.1-5

Problem#3

6.2-2 A compact disc (CD) records audio signals 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 discussed in the text, 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, and the minimum bandwidth required to transmit the encoded signal.

Problem#4

6.2-5 It is desired to set up a central station for simultaneous monitoring of the electrocardiograms (ECGs) of 10 hospital patients. The data from the rooms of the 10 patients are brought to a processing center over wires and are sampled, quantized, binary coded, and time-division multiplexed. The multiplexed data are now transmitted to the monitoring station (Fig. P6.2-5). The ECG signal bandwidth is 100 Hz. The maximum acceptable error in sample amplitudes is 0.25% of the peak signal amplitude. The sampling rate must be at least twice the Nyquist rate. Determine the minimum cable bandwidth needed to transmit these data.

Problem#5

3.20 (a) A sinusoidal signal, with an amplitude of 3.25 volts, is applied to a uniform quantizer of the midtread type whose output takes on the values 0, ±1, ±2, ±3 volts. Sketch the waveform of the resulting quantizer output for one complete cycle of the input.

(b) Repeat this evaluation for the case when the quantizer is of the midrise type whose output takes on the values =0.5, ±1.5, ±2.5, ±3.5 volts.

Problem#6

3.22 Figure P3.22 shows a PCM signal in which the amplitude levels of +1 volt and −1 volt are used to represent binary symbols 1 and 0, respectively. The code word used consists of three bits. Find the sampled version of an analog signal from which this PCM signal is derived.

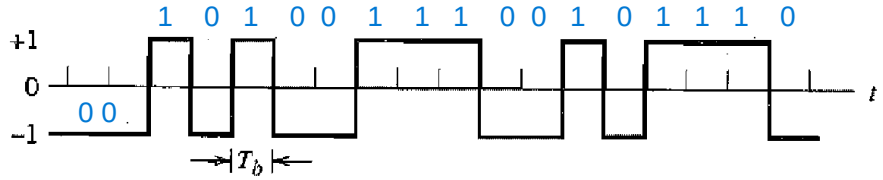

FIGURE P3.22