ORDRE DES INGÉNIEURS DU QUÉBEC

May 2011 SESSION

Open-book examination Calculators: only authorised models Duration: 3 hours

07-ELEC-A3 SIGNALS AND COMMUNICATIONS

SELECT ANY 4 OUT OF 5 PROBLEMS ONLY

Problem No. 1 (25 %)

Determine the frequency domain expression for each of the nonperiodic waveforms in Figure 1 and draw their magnitude and phase spectra.

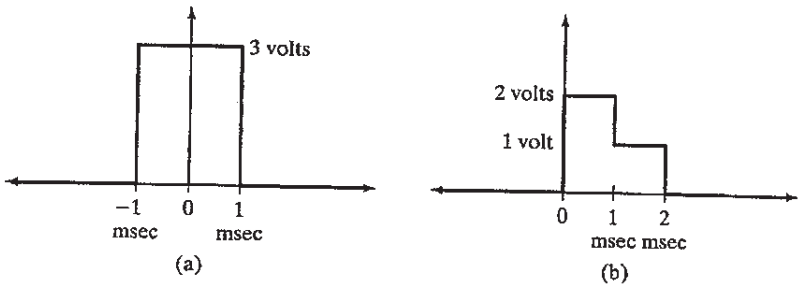


Figure 1. Non periodic waveforms.

Problem No. 2 (25 %)

Consider the signal shown in Figure 2. Suppose the signal is sampled 10,000 times per second and that each sample is uniformly quantized using six bits.

a. What is the dynamic range of the signal?
b. What is the width of the quantization region?
c. What is the maximum quantization error?
d. What is the average normalized power of the quantization noise?
e. How many bits per sample are needed to reduce the maximum quantization error to 12.5 millivolts?

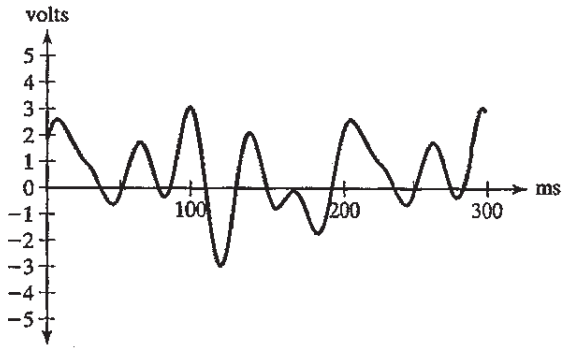


Figure 2. Analog signal requiring sampling and quantizing.

Problem No. 3 (25 %)

The amplitude spectrum of an angle-modulated signal is shown in Figure 3.

a. What is the carrier frequency of the transmitted signal?
b. The information signal was a single sinusoid. What is its frequency?
c. Write the time domain expression for the transmitted signal.

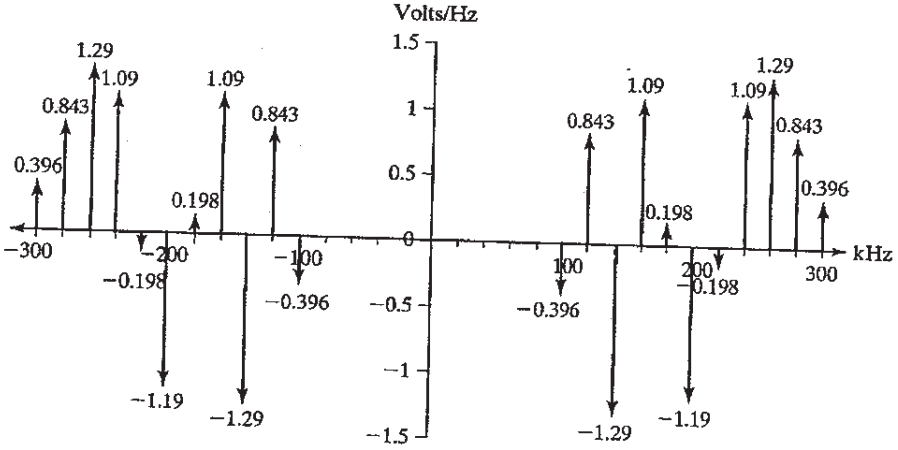


Figure 3. Amplitude spectrum of angle-modulated signal.

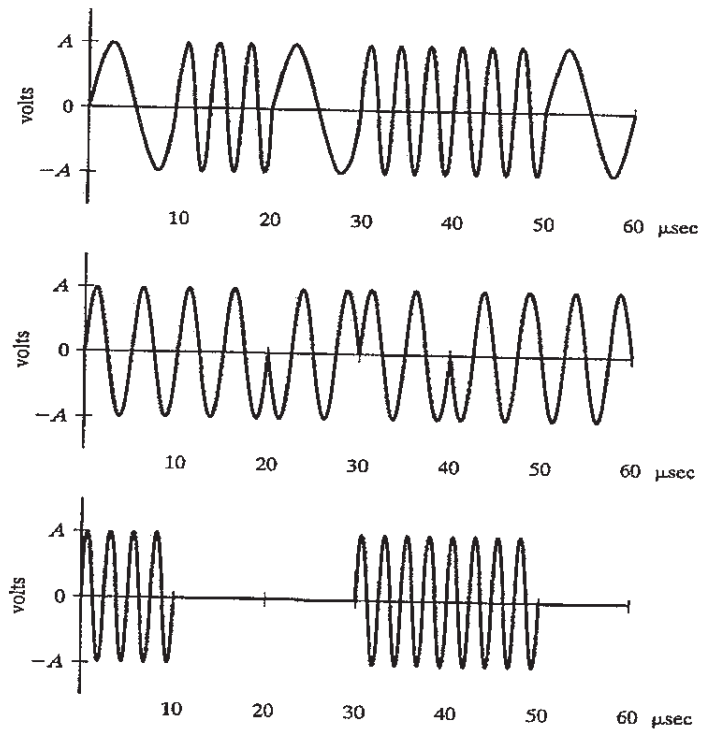
Problem No. 4 (25 %)

Twenty-four audio input signals, each band-limited to 3.3 kHz, are to be multiplexed and transmitted using FDM or TDM.
The frequency-multiplexed systems allow 20% over minimum bandwidth for a guard band, and the time-multiplexed systems sample at 20% over the Nyquist rate.

Determine the minimum bandwidth required for each method if the multiplexing and modulation used is :

a) FDM, SSB-SC
b) FDM, DSB-SC
c) TDM, PAM
d) PAM/AM
e) PAM/PM, $\beta = 9$.

Problem No. 5 (25 %)

Each waveform in Figure 4 is transmitting data at a rate of 100,000 bits/sec . For each waveform, state :

a. the modulation technique
b. the carrier frequency
c. the minimum acceptable channel bandwidth (assume 90% in-band power), maximum acceptable lower cutoff frequency (f_l), and minimum acceptable upper cutoff frequency (f_h)
d. the transmitted data
e. Δf, where applicable