# Communication Systems

**2016 Summer**–Ch7 exercises

**Problem 1:**

Specify the Nyquist rate and the Nyquist interval for each of the following signals:

(a) $g(t) = \text{sinc}(200t)$

(b) $g(t) = \text{sinc}^2(200t)$

(c) $g(t) = \text{sinc}(200t) + \text{sinc}^2(200t)$

**Problem 2:**

Twenty-four voice signals are sampled uniformly and then time-division multiplexed. The sampling operation uses flat-top samples with $1\,\mu s$ duration. The multiplexing operation includes provision for synchronization by adding an extra pulse of sufficient amplitude and also $1\,\mu s$ duration. The highest frequency component of each voice signal is $3.4\,\text{kHz}$.

(a) Assuming a sampling rate of $8\,\text{kHz}$, calculate the spacing between successive pulses of the multiplexed signal.

(b) Repeat your calculation assuming the use of Nyquist rate sampling.

**Problem 3:**

A PCM system that uses a uniform quantizer is followed by a 7-bit binary encoder. The bit rate of the system is equal to $50 \times 10^6\,\text{b/s}$.

(a) What is the maximum message bandwidth for which the system operates satisfactorily?

(b) Determine the output signal-to-quantization noise ratio when a full-load sinusoidal modulating wave of frequency $1\,\text{MHz}$ is applied to the input.

**Problem 4:**

Consider a sine wave of frequency $f_m$ and amplitude $A_m$, applied to a delta modulator of step-size $\Delta$. Show that slope-over-load distortion will occur if

$$A_m > \frac{\Delta}{2\pi f_m T_s}$$

where $T_s$ is the sampling period. What is the maximum power that may be transmitted without slope-overload distortion?

**Problem 5:**

A linear delta modulator is designed to operate on speech signals limited to $3.4\ \text{kHz}$. The specifications of the modulator are as follows:

- Sampling rate = $10 f_{Nyquist}$, where $f_{Nyquist}$ is the Nyquist rate of the speech signal.
- Step-size $\Delta = 100\ \text{mV}$.

The modulator is tested with a 1-kHz sinusoidal signal. Determine the maximum amplitude of this test signal permissible to avoid slope overload.