# Sampling/PCM/DPCM/DM

## Q1.

. The $T_1$ carrier system used in digital telephony multiplexes 24 voice channels based on 8-bit PCM. Each voice signal is usually put through a low-pass fitter with the cut off frequency of about 3.4 kHz. The filtered voice signal is sampled at 8 kHz. In addition a single bit is added at the end of the frame for the purpose of synchronization. Calculate (i) the duration of each bit (ii) the resultant transmission rate and (iii) the minimum         required         transmission         bandwidth.

## Q2.

A DM system is designed to operate at 3 times the Nyquist rate for a signal with a 3-kHz bandwidth. The quantizing step size is 250 mV.

     (i)       Determine the maximum amplitude of a 1-kHz input sinusoid for which the delta modulator does not show slope overload.

     (ii)      Determine the postfiltered output signal to quantizing noise ratio for the signal to part (i).

## Q3.

. A signal at the input to a µ-law (µ=255) compressor is positive with its voltage one half the maximum value. What proportion of the maximum output voltage is produced.

(A) $0.576 \, V_o$                     (B) $0.676 \, V_o$

(C) $0.876 \, V_o$                     (D) $0.976 \, V_o$

## Q4.

The pulse rate in a DM system is 56 kbps. The input signal is $5 \, \text{Cos}(2\pi1000t) + 2 \, \text{Cos}(2\pi2000t)$. Find the minimum value of step size which will avoid slope overload distortion. What would be the disadvantage of choosing a value of larger than the minimum?

## Q6.

If an audio signal of $x(t) = 5\cos 1000 \, \pi t$ is quantized using 10 bit PCM, then the signal to quantization noise ratio is

(A) $2 \times 10^5$                     (B) 50 dB

(C) $1.4 \times 10^5$                  (D) 62 dB

## Q7.

The signal $v(t) = \cos 5\pi t + 0.5\cos 10\pi t$ is instantaneously sampled. The interval between samples is $T_s$.

(i)      Find the Max allowable value for $T_s$.

(ii)      If the sampling signal is $s(t) = 5\sum_{k=-\infty}^{\infty} \delta(t - 0.1k)$, and the sampled signal $v_s(t) = v(t)s(t)$ consists of train of impulses, each with a different strength $v_s(t) = \sum_{k=-\infty}^{\infty} I_k \delta(t - 0.1k)$. Find $I_0$, $I_1$ and $I_2$.

(iii)      To reconstruct the signal $v_s(t)$ is passed through a rectangular low-pass filter. Find the minimum filter B.W. to reconstruct the signal with out distortion.
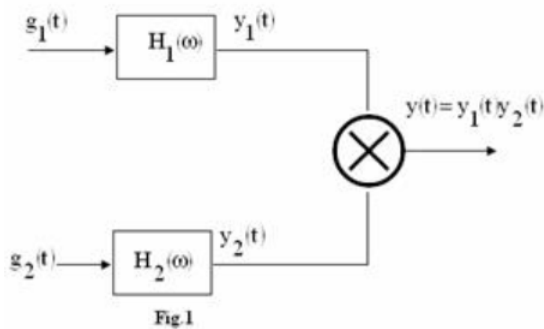
## Q8.

A signal f(t) is band-limited to 4 KHz. The Nyquist rate for sampling of the signal $f(t) + 2f^3(t)$ is given by

(A) 28 KHz                        (B) 8 KHz
(C) 24 KHz                        (D) 12 KHz

## Q9.

a.  Signals $g_1(t) = 10^4 \text{rect}(10^4 t)$ and $g_2(t) = \delta(t)$ are applied as the inputs of an ideal low-pass filters $H_1(\omega) = \text{rect}(\omega/40{,}000\pi)$ and $H_2(\omega) = \text{rect}(\omega/20{,}000\pi)$



Fig.1

The output $y_1(t)$ and $y_2(t)$ of these filters as shown in Fig.1 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 $y(t)$.

## Q10.

A delta modulation system is designed to operate at 3 times the Nyquist rate for a signal with a 3kHz bandwidth. The quantizing step size is 250mV.
(i) Determine the maximum amplitude of a 1kHz input sinusoid for which the delta modulator does not show slope overload distortion.
(ii) Determine the post filtered output signal to quantizing noise ratio for the signal of part (i).

## Q11.

A waveform, $x(t)= 10\cos(1000t+\frac{\pi}{3})+20\cos(2000t+\frac{\pi}{6})$ is to be uniformly sampled for digital transmission (i) What is the maximum allowable time interval between sample values that will ensure perfect signal reproduction. (ii)If we want to reproduce 1 hour of this waveform, how many sample values need to be sorted? (

## Q12.

What does a logic 1 DM bit indicate?

(A) The message signal's amplitude is decreasing.
(B) The feedback signal's amplitude is greater than the message signal's amplitude.
(C) The feedback signal's amplitude is constant.
(D) The feedback signal's amplitude is less than the message signal's amplitude.

## Q13.

A digital communication system is to carry a single voice signal using linearly quantised PCM. What PCM bit rate will be required if an ideal anti-aliasing filter with a cut-off frequency of 3.4KHz is used at the transmitter and the signal to quantization noise ratio is to be kept above 50dB.

## Q14.

What is waveform coding? Explain its salient characteristics. Draw the RZ-UNIPOLAR, NRZ-BIPOLAR, MANCHASTER, NRZ-Unipolar for the data stream 11100101011.

## Q15.

What is the sampling instant signal to noise ratio at the output of a filter matched to a triangular pulse of height 10mV and width 1msec if the noise at the input to the filter is white with a power spectral density of $10nV^2/Hz$.