National Institute of Technology Sikkim,

Department of Electronics and Communication Engineering

Digital Communication (EC15101)

Practice Questions

Set A: Sampling Quantizing Encoding

1. In a digital communication system, transmissions of successive bits through a noisy channel are assumed to be independent events with error probability p. Compute the probability of at most one error in the transmission of an 8-bit sequence.

2. A 4 GHz carrier is DSB-SC modulated by a low pass message signal with maximum frequency of 2 MHz. The resultant signal is to be ideally sampled. Compute the minimum frequency of the sampling impulse train.

3. A signal has frequency components from 300 Hz to 1.8 kHz. Estimate the minimum possible rate at which the signal has to be sampled .

4. A 1.0 kHz signal is flat top sampled at the rate of 1800 samples/sec and the samples are applied to an ideal rectangular LPF with cut-off frequency of 1100 Hz, then estimate the spectral components of the output of the filter.

5. The number of bits in a binary PCM system is increased from n to $n + 1$. As a result, the signal to quantization noise ratio will improve by a factor ____ (in real scale) and _____ in dB.

6. What is the Nyquist sampling frequency (in Hz) of a signal given by $6 \times 104\ \mathrm{sinc}^3(400t) \times 106\mathrm{sinc}^3(100t)$?

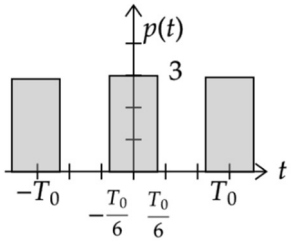
7. The peak-to-peak input to an 8-bit PCM coder is 2 Volts. Compute the signal power-to-quantization noise power ratio (in dB) for an input of $0.5cos(\omega_m t)$.

8. A video transmission system transmits 625 picture frames per second. Each frame consists of a 400 x 400 pixel grid with 64 intensity levels per pixel. What is the data rate of the system?

9. What is the Nyquist sampling interval, for the signal $\mathrm{sinc}(700t) + \mathrm{sinc}(500t)$?

10. During transmission over a communication channel, bit errors occur independently with probability p. If a block of n bits is transmitted, compute the probability of at most one bit error.

11. Let $x(t) = 2\cos(800\pi t) + \cos(1400\pi t)$. $x(t)$ is sampled with the rectangular pulse train shown in the figure below. Compute the spectral components (in kHz) present in the sampled signal in the frequency range 2.5 kHz to 3.5 kHz.



$T = 10^{-3}\ sec$

12. A sinusoidal signal with peak-to-peak amplitude of 1.536 V is quantized into 128 levels using a mid-rise uniform quantizer. Compute the quantization-noise power.

13. A signal is sampled at 8 kHz and is quantized using 8-bit uniform quantizer. Assuming $SQNR$ for a sinusoidal signal, compute R_b and $SQNR$, if R_b is the bit rate.

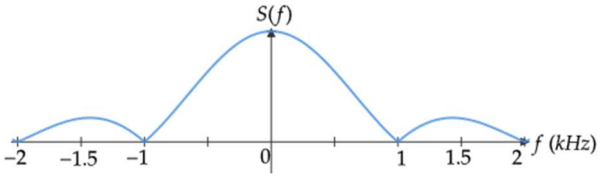
14. Three analog signals, having bandwidths 1200 Hz, 600 Hz and 600 Hz, are sampled at their respective Nyquist rates, encoded with 12 bit words, and time division multiplexed. Compute the bit rate for the multiplexed signal.

15. Consider a Binary Symmetric Channel (BSC) with probability of error being p. To transmit a bit, say 1, we transmit a sequence of three 1s. The receiver will interpret the received sequence to represent 1 if at least two bits are 1. The probability that the transmitted bit will be received in error is _____.

16. Four messages band limited to $W, W, 2W$ and $3W$ respectively are to be multiplexed using Time Division Multiplexing (TDM). What is the minimum bandwidth required for transmission of this TDM?

17. Consider a binary digital communication system with equally likely 0's and 1's. When binary 0 is transmitted the detector input can lie between $-0.25V$ and $+0.25V$ with equal probability. When binary 1 is transmitted, the voltage at the detector can have any value between 0 and $1V$ with equal probability. The detector has a threshold of $0.2V$ (*i.e.*, the received signal is larger than $0.2V$, the bit is declared 1). Compute the average probability of error.

18. A deterministic signal has the power spectrum is given in the figure below. Compute the minimum sampling rate needed to completely represent the signal.



19. An input to a 6-level quantizer has the probability density function $f_X(x)$ as shown in the figure below. Decision boundaries of the quantizer are chosen so as to maximize the entropy (uncertainty) of the quantizer output. It is given that 3 consecutive decision boundaries are $-1, 0$, and 1. Compute a and b.