Subject code: TEC-604

Roll No. to be filled in your Answer Book

Roll No.

B.Tech.
ECE, 6th Semester
Digital Communication (TEC-604)

Time: 3 Hours | Max marks: 100

NOTE:

i. All questions are compulsory.
ii. Draw diagrams wherever necessary.
iii. All questions carry equal marks.

Attempt any FOUR parts of the following. 5 X 4

(A) Determine the differential entropy H(X) of a uniformly distributed random variable X with PDF

$$f_X(x) = \begin{cases} 1/a, & 0 \le x \le a \\ 0, & otherwise \end{cases}$$

(B) What is slope overload distortion and granular noise in delta modulation? How is it removed in ADM?

(C) Explain the need for non-uniform quantization. Also explain μ-law and A-law Companding.

(D) A message signal of $m(t) = 6\cos(2500\pi t) + 2\cos(5000\pi t)$ is passed through delta modulation whose pulse rate is 5000 pulse/second. Find the minimum value of step size required to overcome slope-overload error and the minimum value of step-size required to overcome the granular error.

(E) List five desirable properties of line codes.

(F) Consider a delta modulator with sinusoidal input signal of amplitude A_M and frequency f_m. Show that slope over load distortion will occur if

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

where Δ is the modulator step size and T_s is the sampling period.

2. Attempt any **FOUR** parts of the following 5 X 4

(A) Consider a DMS with alphabet A, A = {-5, -3, -1, 0, 1, 3, 5} with probabilities {0.05, 0.1, 0.1, 0.15, 0.05, 0.25, 0.3}. Source output is quantized according to the following quantization rule:

q (-5) = q (-3) = 4

q (-1) = q (0) = q (1) = 0 and

q (3) = q (5) = 4

Find the entropy of the quantizer output.

(B) State and explain the Shannon's noisy channel coding theorem.

(C) Derive the expression for PSD (Power Spectral Density) for polar signaling and hence comment about its DC null.

(D) Prove that the quantization noise power of a uniform quantizer is $\Delta^2/12$, where Δ is the quantizer step size.

(E) With the help of a block diagram, explain the working of a DPCM system.

(F) A sinusoidal signal is input to a mid-rise type uniform quantizer. Draw the quantizer output for one cycle of input.

3. Attempt any **TWO** parts of the following 10X2

(A) (i) Explain the advantages and applications of spread spectrum modulation. Discuss the frequency hopping spread spectrum technique in detail.

(ii) Explain about PN-sequences generation and their characteristics. What is meant by synchronization? Why we require synchronization in spread spectrum? Explain in detail.

(B) (i) Explain the working principles of QPSK modulation and demodulation.

(ii) Determine the bandwidth required for M-ary FSK system. Draw the geometrical representation of M-ary FSK signals and find out the distance between the signals.

(C) Give the expression of a raised cosine spectrum with roll-off factor $\alpha = 3/4$. Draw the spectrum. Determine its bandwidth and derive the pulse in time domain.

4. Attempt any **TWO** parts of the following 10X2

(A) A source emits three equiprobable messages randomly and independently.

(a) Find the source entropy.

(b) Find the ternary code, the average length of the code word, the code efficiency, and the redundancy.

(c) Repeat part (b) for binary code.

(d) To improve the efficiency of a binary code, we now code the second extension of the source. Find a compact binary code, the average length of the code word, the code efficiency, and the redundancy.

(B) (i) What are the limitations of Nyquist criterion for zero ISI? Explain, how the Nyquist criterion for controlled ISI is useful in removing the above limitation?

(ii) Derive the probability of bit error for coherent binary FSK and PSK.

(C) (i) Explain Gram-Schmidt procedure for orthogonal signals.

(ii) Derive and show that the maximum output SNR of a matched filter is dependent on the energy of the signal only and not on the shape.

5. Attempt any **TWO** parts of the following 10 X 2

(A) Design a (5,3) type systematic block coder with single bit error correction capability. Obtain its generator and parity check matrices.

(B) For the convolutional encoder shown in the figure below:

(i) Draw the state and trellis diagrams and determine the output digit sequence for the data digits 11010100.

(ii) Use Viterbi's algorithm to decode the following received sequences:

(a) 100 110 111 101 001 101 001 010

(b) 111 110 111 111 001 101 001 101

(C) (i) What are the conditions on n and k for (n, k) type cyclic code to exist?

(ii) Consider a (7,4) type systematic cyclic code with generator polynomial $g(x) = 1+x^2+x^3$. Find code words corresponding to message sequences [1011] and [1010].

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