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53 (EC 502) DGCM

2017

## DIGITAL COMMUNICATION

Paper : EC 502

Full Marks : 100

Time : Three hours

**The figures in the margin indicate full marks for the questions.**

Answer **any five** questions.

1. (a) What is meant by 'aperture effect' in sampling process ? How this can be reduced ? 3+1

(b) Show that the 'signal-quantisation ratio' in a binary PCM is given by 6

$$SNR_Q|_{dB} = 1.8 + 6n$$

where 'n' is the number of bits in a code-word.

Contd.

(c) A message signal with a dynamic range of  $-8V$  to  $+8V$  is non uniformly quantised using a  $\mu$ -law compressor with  $\mu = 255$  and 64 quantisation levels. Assume that the quantiser is fully loaded, find the smallest and the largest step sizes obtained. 10

2. (a) Prove that the destination SNR for linear delta modulator (only for granular noise) is given by

$$\left(\frac{S}{N}\right)_D \leq \left(\frac{3}{8\pi^2}\right) \times \left(\frac{f_s}{W}\right)^3;$$

where ' $f_s$ ' is the sampling frequency and ' $W$ ' is the LPF bandwidth. 10

(b) Discuss the operation of a delta modulator (linear). What are the *two* sources of noise in a delta modulator? Discuss them briefly. 6+2+2

3. (a) Discuss the coherent detection of binary ASK bandpass signal and hence calculate the minimum error probability for such scheme. 5+5



- (b) A baseband binary system transmits the signal  $S_1(t)$  for logic 'I' and the signal  $S_2(t)$  for logic 'O' where  $S_1(t)$  and  $S_2(t)$  are given by 10

$$S_1(t) = \begin{cases} +A & ; 0 \leq t \leq T/2 \\ +A/2 & ; T/2 \leq t \leq T \\ 0 & ; \text{elsewhere} \end{cases}$$

and

$$S_2(t) = \begin{cases} +A/2 & ; 0 \leq t \leq T/2 \\ -A/2 & ; T/2 \leq t \leq T \\ 0 & ; \text{elsewhere} \end{cases}$$

The channel may be assumed to be AWGN with noise PSD of  $\eta/2$  and the symbols are equiprobable. Find the energy of the two transmitted signals and hence find the average energy per bit ' $E_b$ '. Also prove that the bit error probability is given by  $P_e = Q \left[ \sqrt{\frac{5E_b}{7\eta}} \right]$ .

4. (a) Calculate the power spectra for a binary FSK (BFSK) signal and hence discuss the result. 10
- (b) If  $x(t)$  is a triangular pulse of 1ms width and  $10^{-2}$  volt height, calculate the SNR at the output of a matched filter. Assume the channel noise to be white and with a PSD of  $10^{-8}$  W/Hz. Explain the role of a matched filter at the front end of a digital communication receiver.

8+2

5. (a) A DMS 'S' has an alphabet  $\{S_0, S_1\}$  with probabilities  $p(S_0) \equiv p_0 = 1/4$  and  $p(S_1) \equiv p_1 = 3/4$ . Find the entropies of the source 'S' and that for the extended source  $S^3$ . 8

(b) Consider a telegraph source having two symbols, dot and dash. The dot duration is 0.2 sec and the dash duration is 3 times that of the dot duration. The probability of the dot's occurring is twice that of the dash, and the time between the symbols is 0.2 sec. Calculate the information rate of the telegraph source. 10

(c) Of the two units of information, bit and nit, which is bigger? How are they related? 2

6. Write short notes on **any two** from the following: 10+10

(a) Bandwidth-power trade-off in PCM systems

(b) Discrete memoryless channel (DMC)

(c) Error probability with matched filter for polar signalling

(d) Line coding in digital communication system.