53 (EC 502) DGCM

2016

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)* State sampling theorem for band-limited low pass signals. Hence show that the output from the 'reconstruction filter' will be

$$x(t) = \sum_{n=-\infty}^{\infty} x(nTs)\,Sinc[2B(t - nTs)];$$

where the symbols have their usual meaning. 2+8

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

(c) Show that the 'signal-quantization ratio' in a binary PCM is given by

$SNR_Q/_{dB} = 1{\cdot}8 + 6n$; where '$n$' is the number of bits in a code-word. 6

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

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

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

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

3. *(a)* A baseband binary system transmits the signal $S_1(t)$ for logic '1' and the signal $S_2(t)$ for logic '0', where $S_1(t)$ and $S_2(t)$ are given by

$$S_1(t) = \begin{cases} A; 0 \le t \le T/2 \\ \frac{A}{2}; \frac{T}{2} \le t \le T \\ 0 \text{ ; elsewhere,} \end{cases}$$

and

$$S_2(t) = \begin{cases} \frac{A}{2}; 0 \le t \le \frac{T}{2} \\ -\frac{A}{2}; \frac{T}{2} \le t \le T \\ 0 \text{ ; elsewhere.} \end{cases}$$

The channel may be assumed to be AWGN with noise PSD of $n/2$ and the symbols are equiprobable. Find the energy of the two transmitted signals $S_1(t)$ and $S_2(t)$ and hence find the average energy per bit 'Eb'. Also prove that the bit error probability is given by $P_e = Q\left[\sqrt{\frac{5Eb}{7\eta}}\right]$. 10

(b) If $x(f)$ 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 $10^{-8} W/Hz$. What is the role of a matched filter at the front-section of a digital communication receiver ? 8+2

4. (a) A microwave link is used for transmitting binary data at the rate of $1 Mbps$. Assuming the PSD (two sided) of the noise at the input of the receiver to be $10^{-10} W/Hz$, find the average carrier power required to be maintained if the probability of error (Pe) is not to exceed 10^{-4}, when *(i)* coherent BPSK and *(ii)* coherent BFSK are used. Given, inverse complimentary error function of $2 \times 10^{-4} = 2{\cdot}629$. 10

(b) Discuss the coherent detection of ASK bandpass signals and hence calculate the minimum error probability for such scheme. 5+5

5. *(a)* Consider a telegraph source having *two* symbols, dot and dash. The dot duration is 0·2sec and the dash duration is 3 times 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

(b) For a lossless channel, show that $H(X/Y) = 0$, where the symbols have their usual meaning. 5

(c) 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 the extended source S^3. 5

6. Write short notes on : ***(any two)*** 10+10

(i) Discrete memoryless channel (DMC)

(ii) Power spectra of binary FSK signal

(iii) Optimum filter for digital baseband signalling.
