53 (EC 502) DGCM

2018

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 'aperture effect' in practical sampling? Show the input-output characteristics of two uniform quantizers. Hence show that the mean-squared value of quantizer is $\overline{eq}^2 = \Delta^2/12$, where '$\Delta$' is the step size. 3+2+5

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

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

   where the symbols have their usual meaning. 8+2

2. *(a)* Show that the $SNR_Q/_{dB}$ in a binary PCM is given by $SNR_Q/_{dB} = 1.8 + 6n$; where 'n' is the number of bits in a code-word. 10

(b) Derive the expression for maximum SNR_Q for a sinusoidal message input. Waveform coding is to be done by delta modulator under no slope overload condition. 10

3. *(a)* What is menat by: RZ and NRZ line codes? Discuss and draw the different types of line codes. 2+8

(b) A message signal bandlimited to $4kHz$ is to be transmitted using a PCM system. If the quantization error of any sample is to be at the most $\pm$ 1% of the dynamic range of the message signal, determine the minimum value of 'n' the minimum sampling rate and the corresponding bit rate of transmission. 10

4. A baseband binary system transmnits the signal $S_1(t)$ for binary 1 and $S_2(t)$ for binary 0, where

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

and

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

The channel may be assumed to be AWGN with noise PSD of 'No/2' and the symbols are equiprobable. Find the energy of the two transmitted signals and hence find the average energy per bit. Also find the probability of bit error '*Pe*'. 20

5. *(a)* A microwave link is used for transmitting binary data at the rate of $1Mbps$. Assuming the 2-sided PSD 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. Assume inverse complimentary error function of $\left(2 \times 10^{-4}\right) = 2.629$. 7+7

(b) If $x(t)$ is a triangular pulse of $1ms$ width and 10^{-2} volts height; calculate the SNR at the output of a matched filter. Assume the channel noise to be white with a PSD of 10^{-8} W/Hz. 6

6. *(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 $0.2sec$. 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. 10
