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Paper Code : EC-601

DIGITAL COMMUNICATION

Time Allotted : 3 Hours | *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable

GROUP – A

(Multiple Choice Type Questions)

1 Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) On-off signaling is known as
   a) Bipolar signaling
   b) Polar signaling
   c) Manchester signaling
   d) Unipolar signaling.

ii) To avoid aliasing, what is the nyquist rate of the signal $x(t) = 8\cos 100\pi t$?
   a) 25Hz b) 50Hz
   c) 100Hz d) 200Hz.

iii) In a PCM system, the number of quantisation level is 16 and the maximum signal frequency is 4 kHz, the bit transmission rate is
   a) 64 kbps b) 32 kb_ps
   c) 16 kbps d) 32 mbps.

iv) The SNR in PCM system depends on
   a) sampling rate
   b) number of quantisation levels
   c) message signal bandwidth
   d) none of these.

v) Regenerative repeaters can be used in
   a) Analog Communication system only
   b) Digital Communication system only
   c) Analog & Digital Communication system
   d) None of these.

vi) The use of non-uniform quantization leads
   a) reduction in transmission bandwidth
   b) increase in maximum SNR
   c) increase in SNR for low signal levels
   d) simplification of quantization process.

vii) For generation of FSK, the data pattern must be given in
   a) RZ format
   b) NRZ format
   c) Split phase Manchester
   d) None of these.

viii) BPSK signal can be demodulated by using

a) a low pass filter b) a band pass filter

c) a high pass filter d) none of these.

ix) The probability density function (PDF) of the envelope of narrowband Gaussian noise is

a) Poisson b) Gaussian

c) Rayleigh d) Rician.

x) In a Delta Modulation system, the granular noise occurs when the modulating signal,

a) increases rapidly

b) changes within the step size

c) decreases rapidly

d) has high frequency component.

xi) Adaptive Delta Modulation is preferred over Delta Modulation as

a) it gives better noise performance

b) it uses lesser bits for encoding the signal

c) it does not suffer from slope overload and thershold effect

d) it has simpler circuitry.

xii) Which of the following digital modulation techniques is used for high speed telephone modems ?

a) QAM b) GMSK

c) QPSK d) none of these.

xiii) For encoding the binary data, the Differential encoding uses

a) signal transitions b) signal frequency

c) signal amplitude d) signal phase.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Draw the block diagram of modulator and demodulator of a delta modulation system. What do you mean by ADM ? 3 + 2

3. Explain the operation of PCM system with appropriate diagram.

4. A uniform distributed random variable X has a probability density function given by

$f_x(x) = 1/2\pi$ for $0 \le x \le 2\pi$

$= 0$ otherwise

Determine $E[X]$, $E[X^2]$, $E[\cos(X)]$ and $E[(X-m_x)^2]$.

explain the operation of regenerative repeater. If the bit error probability of such a repeater is 10^{-5}, then what will be the overall bit error probability of 45 identical repeaters placed 30 km apart from each other ? 4 + 1

b. Find the decision threshold if conditional probability density functions after addition of noise are of Gaussian distribution and voltage V_1 represents symbol s_1 and voltage V_2 represents symbol s_2 for no noise case. Determine the threshold when a priori probabilities are equal

a) for bipolar signal with $V_1 = +V$, $V_2 = -V$.

b) for unipolar signal with $V_1 = +V$ and $V_2 = 0$.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7 a) Draw the transmitter and receiver of DPCM and explain their operations. 6

b) If the base band signal is given by $A \sin \omega_m t$, determine the expression for maximum value of 'A' to avoid slope overloading problem. 3

c) What is pulse modulation ? What are the different types of pulse modulation techniques ? Draw and explain the waveform of each type of pulse modulated signals for monotonic base-band. 1 + 1 + 4

8. a) What is sampling ? Explain natural and flat-top sampling. Compare the two. 1 + 3 + 1

b) State and prove sampling theorem. 5

c) A television signal has a bandwidth of 4.5 MHz. This signal is sampled and converted into a PCM signal.

i) Determine the sampling rate if the signal is to be sampled at a rate of 20% above the Nyquist rate.

ii) If the samples are quantized into 1024 levels, determine the number of binary pulses required to encode each sample.

iii) Determine the binary pulse rate (bits per second) of the binary coded signal. 5

9. a) What is ISI ? How is eye diagram useful to detect the effect of ISI ? 2 + 4

b) What is Nyquist first criteria for zero ISI ? Show that duo-binary pulses can be used to satisfy Nyquist second criteria for zero ISI. 2 + 5

c) If the roll off factor of a pulse is 0.75 and the bit rate is 1 Mbps, determine the bandwidth of the pulse. 2

10. a) What is a matched filter ? Deduce the transfer function of a matched filter. 1 + 5

b) Deduce the expression of the error probability for an integrate and dump filter. Show the variation of the error probability with SNR and explain its significance. 5

c) What is 'optimum' filter ? In presence of white Gaussian noise, calculate the error probability for optimal reception of an antipodal binary digital signal having equal energy for both the states. 1 + 3

11. a) Draw and explain the working of QPSK modulator. 3

b) A digital data '1110010' is transmitted with DPSK technique. Explain the reception by considering bit '1' as initial bit. Show that the reception is independent of initial bit. 7

c) Compare the performance of QPSK and BPSK. Why QAM is more suitable for high speed wire-line system ? 3 + 2

12. a) Compare the constellation diagram of ASK and OOK. Write the advantages of PSK over ASK. 2 + 2

b) Explain the coherent and non-coherent detection of BPSK signal. 5

c) Compare binary modulation and M-ary modulation. If the data rate for a 16-QAM is 256 kbps, what will be the symbol rate ? 3

d) Why OQPSK is more suitable than QPSK for long distance communication ? 3

13. a) What do you mean by random process ? Explain strict sense and wide sense stationary process. 2 + 3

b) The joint PDF of the random variables X and Y is

$Pxy(x, y) = \lambda \exp[-x(y+1)]$ for $0 \le x \le \infty$, $0 \le y \le \infty$,

$= 0$ otherwise.

i) Find $Px(x)$ and $Py(y)$.

ii) Are the random variables dependent or independent ? 2 + 2 + 1

c) Show that the signals $x_n(t) = A \cos n\omega_0 t$, $n = 0, 1, 2, \ldots$ where $\omega = 2\pi/T$, form a set of orthogonal functions over the interval $[0, T]$. Are they orthonormal ? If not, obtain an orthonormal set. 5

14. Write short notes on any three of the following : 3 × 5

a) Non-uniform quantization

b) Quantization noise in PCM

c) Stationary process

d) Frame synchronization

e) Line coding

f) Early-late gate bit synchronizer.