DIGITAL COMMUNICATION
(ECEN 3101)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.*

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i)   Nyquist sampling rate for the composite signal $S = 5 \cos 4000 \pi t \cdot \cos 2000 \pi t$
   (a) 3KHz   (b) 4 KHz   (c) 5 KHz   (d) 6 KHz.

   (ii)   The length of the code-word required to encode L number of quantizer level is equal to
   (a) $n = \log_2 L$ (b) $n = \log_{10} L$ (c) $n = 2 \log_2 L$ (d) $n = \log_2 L/2$

   (iii)   Increase in eye opening in eye diagram means _____ in ISI
   (a) Increase   (b) Decrease   (c) No change   (d) No dependency.

   (iv)   If in any PCM system, the number of bits/per sample is increased from 5 to 7, the increase in absolute value of signal to quantization noise ratio will be
   (a) 8   (b) 16   (c) 32   (d) 64

   (v)   If each pulse can be shaped in ____ shape, the symbols can be detected without ISI.
   (a) Sine   (b) Cosine   (c) Square   (d) None of the mentioned

   (vi)   The detection method where carrier's phase and frequency are given importance is called as
   (a) Coherent detection   (b) Non coherent detection
   (c) Coherent detection & Non coherent detection   (d) None of the mentioned.

   (vii)   In Delta Modulation, the bit rate is same as
   (a) the sampling rate   (b) the modulating frequency
   (c) the Nyquist rate   (d) none of the above.

   (viii) Adaptive Delta Modulation is preferred over Delta Modulation for
   (a) better noise performance   (b) lesser bits to encode samples
   (c) avoiding slope overload and granular noise   (d) simpler circuit.

   (ix)   A system is using RZ format to transfer the data at 10 Kbps rate. The minimum bandwidth required for the channel
   (a) 5 KHz   (b) 10 KHz   (c) 20 KHz   (d) 30 KHz.

(x)   QPSK is a composite of
    (a) Two BPSK   (b) Three BPSK   (c) Two FSK   (d) Two M-ary PSK.

Group - B

2. (a)   What is flat top sampling ? Mention the limitation of flat top sampling and how it can be reduced?   [(CO1) & (CO2)(Remember/LOCQ)]

   (b)   Specify the Nyquist sampling rate of the sampler to send the signal S(t) = 4 Cos 6000 πt + 6 Cos 4000 πt. Suppose in this system a noisy signal n(t) = Cos 10000 πt is added with signal S and the composite signal S(t) + n(t) is sampled by the same sampler. What is the effect you may observe during reconstruction of the signal S? What do you suggest to avoid this problem and detect signal S perfectly?
                                                                          [(CO2)(Evaluate/HOCQ)]

   (c)   A band-limited sinusoid signal m(t) of 4 kHz bandwidth is sampled at rate of 25% higher than the Nyquist rate using a PCM system. The maximum allowable quantization error in the sample amplitude is 0.4% of the peak amplitude. Assuming binary encoding, specify the minimum supporting bit rate of the channel to transmit the encoded binary signal.   [(CO2)(Analyse/IOCQ)]
                                                                          (2 + 2) + (1 + 2 + 1) + 4 = 12

3. (a)   What is the fundamental change in Delta Modulation system from PCM to enhance the correlation among the samples. Identify the limitations in Delta Modulation.
                                                                          [(CO2)(Analyse/IOCQ]

   (b)   Design a PCM system (specify the maximum Sampling frequency, Quantizer step size, number of bits of the Encoder & maximum output bit rate) for a input signal f(t) = 2 Cos 2000 πt which is to be transmitted through a channel of bandwidth 56 KHz and maintain at least SNRq of 40 dB.   [(CO2)(Create/HOCQ)]

   (c)   In case, the above signal f(t) in (b) is to be transmitted through DM with step size Δ = 200 mV and sampling at five times the Nyquist rate. Calculate the maximum amplitude of the input sinusoid signal for which the delta modulator does not have slope overload.   [(CO2)(Apply/IOCQ)]
                                                                          (1 + 3) + 6 + 2 = 12

Group – C

4. (a)   Favourable PSD is one of the desirable properties of line code: Justify the statement with the example of a line code which ensures satisfaction of this property.
                                                                          [(CO3)(Analyse/IOCQ)]

   (b)   In a digital communication system which parameters guides us to select appropriate line code? Elaborate with proper example.   [(CO1) & (CO3)(Analyse/IOCQ)]
                                                                          4 + 8 = 12

5. (a)   Compare the performance of RZ and NRZ formats for data transmission?
                                                                          [(CO3)(Understand/LOCQ)]

   (b)   A communication channel with 50 kHz BW is required to transmit a data at a rate of 0.1 Mbps using raised cosine pulse. Determine the roll-off factor.
   [(CO3)(Analyse/IOCQ)]

(c) How a regenerative repeater helps to increase transmission path length in a Digital Communication System? Why analog communication system cannot use the same technique to increase the path length? [(CO2) & (CO3)(Understand/LOCQ)]

[(CO1) & (CO3)(Analyse/IOCQ)]

4 + 3 + (3 + 2) = 12

Group – D

6. (a) For a bit sequence of 10001101 draw the resulting waveform both in time and frequency domain for (i) ASK (ii) FSK (iii) PSK modulation scheme.

[(CO5)(Understand/LOCQ)]

(b) Design a DPSK modulation system using differential encoder and from this design point out its advantage over PSK modulation system. [(CO5)(Apply& Analysis/IOCQ)]

6 + 4 + 2 = 12

7. (a) Identify the limitations of QPSK . How these limitations are overcome in MSK?

[(CO5)(Analysis/IOCQ)]

(b) Explain the operation of ASK modulation system with suitable diagram.

[(CO5)(Understand/LOCQ)]

(c) M-ary modulation saves bandwidth but make the system less immune to noise over binary modulation: Establish the statement with proper example.

[(CO5)(Analysis/IOCQ)]

(2 + 2) + 4 + 4 = 12

Group – E

8. (a) Under which condition a correlation receiver acts as a matched filter ?

[(CO4) & (CO4)(Analysis/IOCQ)]

(b) Design a correlation receiver which will maximize SNR at receiver output.

[(CO4)(Apply/IOCQ)]

(c) Draw the impulse response of the matched filter with the waveform given below as its input.
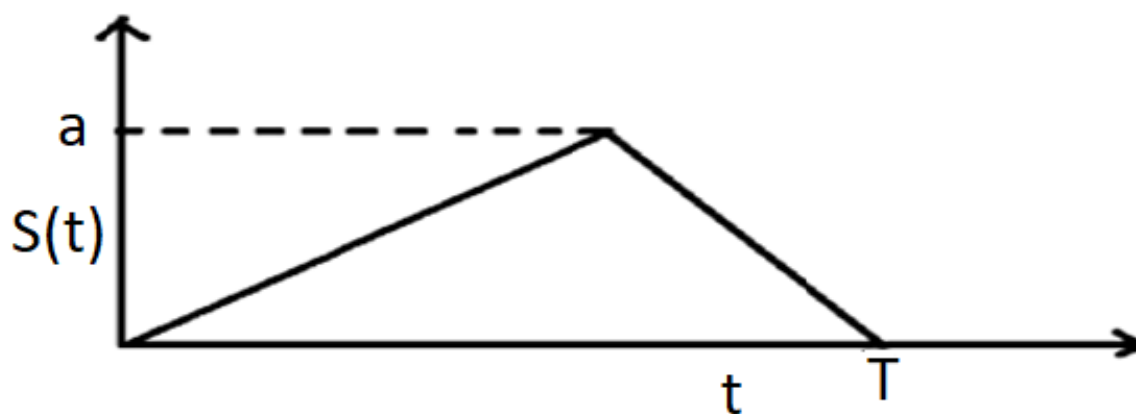
[(CO4) & (CO6)(Evaluate/HOCQ)]

2 + 6 + 4 = 12

9. (a) The maximum SNR of a matched filter is $\eta_{max} = \frac{2}{N_0} \int_{-\infty}^{\infty} |G(f)|^2 \, df$. Show that maximum SNR of a matched filter is independent of signal shape but depends only on the signal energy. Symbols have their usual meanings.

[(CO4), (CO5) & (CO6)(Analysis/IOCQ)]

(b) With the help of proper diagram compare the error performance of the binary modulation techniques. [(CO5) & (CO6)(Analysis/IOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	21.88	63.54	14.58

Course Outcome (CO):

After the completion of the course students will be able to

1. Apply the concepts of various techniques for analog signal transmission and modulation from the knowledge gathered earlier.
2. Understand the functions of different components of a digital communication system and understand Pulse code Modulation System.
3. Apply mathematical concepts to analyse the source coder and channel coder blocks of the digital communication system.
4. Analyze error performance of a baseband receiver in digital communication system in presence of noise and other interferences and apply this knowledge to design a receiver.
5. Compare performance of various digital modulation & demodulation techniques and understand concept of OFDM and Spread Spectrum Modulation system.
6. Design a digital communication system and evaluate the performance of the system in presence of noise.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question