DIGITAL COMMUNICATION
(ECEN 3101)

Time Allotted : 2½ hrs   **Full Marks : 60**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
<u>any 4 (four)</u> from Group B to E, taking <u>one</u> from each group.*

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

  (i)   Quantization noise can be reduced by _____ the number of quantizer levels.
        (a) decreasing   (b) increasing
        (c) independent of quantization level   (d) none of (a), (b) & (c)

  (ii)   Companding is used
        (a) to overcome quantization noise in PCM
        (b) in PCM transmitters, to allow amplitude limiting in the receiver
        (c) to protect small signals in PCM from quantization distortion
        (d) in a PCM receiver, to overcome impulse noise.

 (iii)   In uniform quantization process
        (a) the step size remains same
        (b) step size varies according to the values of the input signal
        (c) the quantizer has linear characteristics
        (d) both (a) and (c) are correct.

  (iv)   In a DM system, the granular noise occurs when the modulating signal
        (a) increase rapidly
        (b) remains constant
        (c) decreases rapidly
        (d) the nature of modulating signal has nothing to do with this noise.

  (v)   _____ encoding has a transition at the middle of each bit.
        (a) Manchester   (b) P-RZ
        (c) Both (a) & (b)   (d) None of (a) & (b)

  (vi)   Granular noise in DM occurs when
        (a) step size is too small
        (b) step size is too large
        (c) there is interference from the adjacent channel
        (d) bandwidth is too large.

(vii)   Regenerative repeaters are used for
(a) Eliminating noise   (b) Reconstruction of signals
(c) Transmission over long distances   (d) All of the (a), (b) & (c).

(viii)   In a PCM system an increase in the number of quantization levels, the encoded bit size changes from 6 bits to 8 bits. The signal-to-quantization noise ratio changes by
(a) 36 dB   (b) 48 dB   (c) 12 dB   (d) 2 dB

(ix)   An analog signal has significant spectral components from 1 kHz to 5 kHz. What is the Nyquist sampling rate for this signal?
(a) 5 k samples/s   (b) 8 k samples/s
(c) 10 k samples/s   (d) 4 k samples/s.

(x)   A rectangular pulse of duration T is applied to matched filter. Output to the filter is
(a) a rectangular pulse of duration T   (b) rectangular pulse of duration 2T
(c) triangular pulse   (d) impulse function.

Fill in the blanks with the correct word

(xi)   Nyquist sampling rate for the composite signal S = 4 Cos 3000 πt . Cos 2000 πt is _____.

(xii)   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 ____.

(xiii)   A system is using RZ format to transfer the data at 10 Kbps rate. The minimum bandwidth required for the channel _____.

(xiv)   For a given data rate, the bandwidth of a BPSK signal is _____ the bandwidth of the QPSK signal.

(xv)   One of the application of spread spectrum is in _____.

Group - B

2. (a)   State Sampling theorem. Discuss the operation of Sample & Hold circuit with proper diagram.   *[(CO1)(Remember/LOCQ)][(CO1)(Analyse/IOCQ)]*
    (b)   In a Digital Communication System the number of quantization level is 16 and the maximum frequency of the message signal is 4 kHz. Calculate the bit transmission rate.   *[(CO1)(Apply/IOCQ)]*
    (c)   Explain quantization noise. How does the step size of the uniform Quantizer decide the SNR of a PCM system?   *[(CO2)(Understand/LOCQ)][(CO1)(Analyse/IOCQ)]*
                                         (1 + 3) + 4 + (2 + 2) = 12

3. (a)   Explain the working principle of a Delta Modulator (DM) with a block diagram.
                                                                    [(CO2)(Understand/LOCQ)]
    (b)   Identify the limitations of DM.   *[(CO2)(Analyse/IOCQ)]*
    (c)   A DM system is designed to operate at 5 times the Nyquist rate for a signal with 4 kHz maximum frequency. The quantization step size is 200 mV.

Estimate the maximum amplitude of a 2 kHz input signal for which DM system does not show slope overload. *[(CO2)(Apply/IOCQ)]*

4 + 4 + 4 = 12

Group - C

4. (a) In a digital communication system which parameters guide us to select appropriate line code? Elaborate with proper examples. *[(CO3)(Analyse/IOCQ)]*

(b) To transmit a bit sequence of 011001, draw the resulting waveform using (i) Unipolar RZ (ii) Polar-NRZ (iii) Bipolar NRZ or AMI (iv) Manchester Coding. *[(CO3)(Apply/IOCQ)]*

(c) Mention some advantages of Manchester coding. *[(CO3)(Remember/LOCQ)]*

(4 + 2) + 4 + 2 = 12

5. (a) In a digital communication system, how does a regenerative repeater contribute to a longer transmission path? Is it possible to use a regenerative repeater in analog communication for the same purpose? Justify your answer. *[(CO4,CO6)(Analyse/IOCQ)]*

(b) A communication channel with 100 KHz BW is required to transmit data at a rate of 0.15 Mbps using raised cosine pulse. Determine the roll-off factor. *[(CO4)(Apply/IOCQ)]*

(c) How do you visualize the effect of ISI in the received data? How can the best time for sampling be decided from this arrangement? *[(CO4,CO6)(Understand/LOCQ)]*

(4 + 2) + 3 + (1 + 2) = 12

Group - D

6. (a) Design a DPSK modulation system using differential encoder and from this design point out its advantage over the PSK modulation system. *[(CO5)(Apply/IOCQ)][(CO5)(Analyse/HOCQ)]*

(b) Draw BFSK & BPSK modulated waveform for the data stream 100100111. *[(CO5)(Apply/IOCQ)]*

(6 + 2) + 4 = 12

7. (a) With suitable diagrams, explain the working principle of the QPSK transmitter and draw its signal space diagram. *[(CO5)(Understand/LOCQ)]*

(b) An 8–PSK modulated signal has the bit rate 12 kbps. Find the baud rate. *[(CO5)(Apply/IOCQ)]*

(c) Compared to binary modulation, *M*-ary modulation saves bandwidth but reduces the system's noise immunity: Justify the statement. *[(CO5)(Analyse/IOCQ)]*

(4 + 2) + 3 + 3 = 12

Group - E

8. (a) Draw the impulse response of the matched filter with the waveform given below as its input.

$s_1(t)$ ... T ... t

$s_2(t)$ ... T ... t
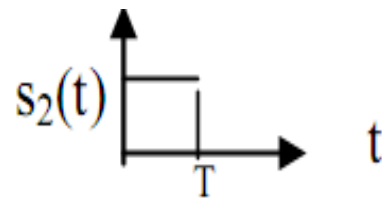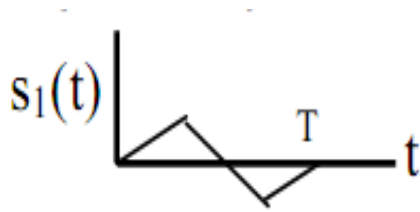
(b)   Describe the operation of an Integrate & Dump filter.   *[(CO6)(Analyse/HOCQ)]*

[(CO6)(Remember/LOCQ)]

6 + 6 = 12

9. (a)   In a noisy channel which digital binary modulation technique (ASK/FSK/PSK) will ensure the minimum value of BER? Establish your statement by calculating the distance between the symbols from the signal space diagram.

[(CO6)(Analyse/HOCQ)]

(b)   Explain the operation of spread spectrum based digital cordless phones. Mention the facilities of using 2.4 GHz carrier frequency for digital cordless phones.   *[(CO5)(Understand/LOCQ)]*

6 + (4 + 2) = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	36.45	42.7	20.8

Course Outcome (CO):

After completing the course the student 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.