ADVANCED DIGITAL COMMUNICATION TECHNIQUES
(ECEN 5201)

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) Maximum quantization error in binary PCM is
   (a) $\pm S/2$ (b) $\pm S$
   (c) $\pm 2S$ (d) S^2 where, S= Step size.

   (ii) For hamming distance d_{min} and t errors in the received word, the condition to be able to correct the errors is
   (a) $2t + 1 \le d_{min}$ (b) $2t + 2 \le d_{min}$
   (c) $2t + 1 \le 2d_{min}$ (d) Both (a) and (b).

   (iii) Convolutional codes can be defined by (n, k, K) where n represents
   (a) encoder output   (b) input bits
   (c) constraint length   (d) none of these.

   (iv) In a GSM system the uplink frequency is 935 MHz. The downlink frequency will be
   (a) 890 MHz   (b) 980 MHz
   (c) 845 MHz   (d) 1025 MHz.

   (v) The maximum data rate of a channel is calculated by
   (a) $4B \log_2 M$ (b) $B \log_2 M$
   (c) $2B \log_{10} M$ (d) $B \log_{10} M$ where, M= (1+ SNR).

   (vi) In eye pattern, as eye closes,
   (a) Timing jitter increases   (b) ISI decreases
   (c) Timing jitter increases   (d) ISI increases.

   (vii) In data communication, the following will be the outputs of the given operations
   (a) 1+1=1   (b) 1-1=0
   (c) 1+1= 0 and no carry   (d) 1+1=0 with carry=1.

(viii) MIMO stands for
(a) Multiple Input Minimum Output   (b) Multiple Input More Output
(c) Multiple Input Multiple Output   (d) More Input More Output.

(ix) The Rake receivers are provided in the receiver circuit in
(a) GSM systems
(b) Any radio communication system
(c) CDMA systems
(d) Satellite communication systems.

(x) In data communication, modulo 2 operation is applied during addition because
(a) noise is regular in nature   (b) noise is random
(c) noise has no role   (d) noise affects only one bit.

Group- B

2. (a) Draw the block diagram for a basic digital communication system.
[(CO1)(Remember/LOCQ)]
   (b) Explain the functions of 'Source Encoding' and 'Channel Encoding'.
[(CO5)(Understand/IOCQ)]
   (c) Show the schematic diagram for Linear Gaussian Channel model and write the expression for the output, Y(t).   [(CO1)(Remember/IOCQ)]
4 + 3 + 5 = 12

3. (a) What is ISI in digital communication and why does it occur?
[(CO6)(Analyse/IOCQ)]
   (b) Explain the ISI phenomenon using the baseband equivalent channel model.
[(CO6)(Analyse/HOCQ)]
   (c) Draw the equivalent transmission system model with the equalizer. What is the function of the equalizer?   [(CO4)(Analyse/IOCQ)]
4 + 3 + 5 = 12

Group - C

4. (a) Represent QPSK mathematically. Draw the signal space diagram for QPSK signal.
[(CO2)(Understand/IOCQ)]
   (b) How is PSK generated? Explain with block diagram. Draw the PSK waveform for the data string 0110100.   [(CO2)(Analyze/IOCQ)]
(3 + 3) + (3 + 3) = 12

5. (a) How does multi-carrier CDMA system work?   [(CO3)(Understand/IOCQ)]
   (b) Explain with block diagrams the operations of OFDM transmitter and OFDM receiver.   [(CO3)(Remember/LOCQ)]
   (c) How is OFDMA derived from OFDM?   [(CO3)(Analyze/HOCQ)]
4 + 5 + 3 = 12

Group - D

6. (a) Derive the equation for system bandwidth as a function of channel capacity and SNR.   [(CO4)(Analyse/HOCQ)]
    (b) Show with diagram how is DS-SS is generated. Create a spread spectrum signal using Barker sequence. Use any data sequence signal as input.
                                                     [(CO3)(Analyse/HOCQ)]
    (c) State two advantages of using DS-SS system.   [(CO1)(Remember/LOCQ)]
                                         5 + (2 + 3) + 2 = 12

7. (a) How does slotted ALOHA work?   [(CO1)(Remember/LOCQ)]
    (b) How does MAI limit number of CDMA users?   [(CO3)(Understand/LOCQ)]
    (c) State the important features of CDMA. How does Bluetooth work? Explain briefly for a piconet.   [(CO1)(Analyze/IOCQ)]
                                             3 + 3 + 6 = 12

Group – E

8. (a) Explain with the help of the coding gain curve, how a minimum values of (E_b/N_0) is important.   [(CO6)(Analyse/HOCQ)]
    (b) What are the characteristics of a 'Finite Field' or 'Galois Field'?
                                                [(CO5)(Understand/IOCQ)]
    (c) The generator matrix for a (6,3) block code is given below. Find all the code vectors of this code.

$$G = \begin{bmatrix} 100110 \\ 010011 \\ 001111 \end{bmatrix}$$

                                                 [(CO5)(Analyse/HOCQ)]
                                             3 + 3 + 6 = 12

9. (a) What is the function of estimation in communication? Explain.
                                                [(CO4)(Remember/LOCQ)]
    (b) What are the factors to be considered during detection? Why does error probability play a vital role in the optimal detection?
                                                [(CO4)(Understand/IOCQ)]
    (c) Why is maximum likelihood decision critical in digital communication?
                                                 [(CO4)(Analyse/HOCQ)]
                                             4 + 5 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	21.87	48.96	29.17

Course Outcomes (CO):

1. Students will learn about the transmission techniques, synchronization in digital communication.
2. They will know about the modulation schemes, OFDM etc.
3. The students will acquire knowledge about the CDMA in details.
4. The students will have clear idea about estimation and detection schemes. They will be able to design reliable channel codings.
5. They will understand the differences between coding schemes.
6. The students will be able to analyse the digital communication quality.

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