

**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  
any 5 (five) from Group B to E, taking at least one 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) Which of the following statements is true?
    - (a) Source coding reduces the total number of information bits
    - (b) Source coding is the first block in data communication system
    - (c) In source coding, the probability of occurrence affects the number of bits
    - (d) All three are true.
  - (ii) In data communication system, modulo-2 function is mandatory because
    - (a) the carry cannot be considered
    - (b) the carry is not generated
    - (c) the noise is random in nature
    - (d) there is no role of noise nature.
  - (iii) Which of the following statements is true?
    - (a) Matching filters maximize the output at the receiver
    - (b) Matching filters maximize the output at the transmitter
    - (c) Matching filters are required when the waveform is not known
    - (d) Both (a) and (c) are true.
  - (iv) In data communication system, one event has probability of 0.1 and a second event has a probability of 0.2. Both are source coded.
    - (a) The number of bits required for 0.2 will be more
    - (b) The number of bits required for 0.1 will be more
    - (c) The number of bits will be same for both
    - (d) None is true.
  - (v) The source data is split up into I and Q components. The phase angle between them is
    - (a) 180 degrees
    - (b) 270 degrees
    - (c) 90 degrees
    - (d) None is true.

- (vi) Which of the following statements is true?  
(a) Equalizer circuits reduce the ISI problem  
(b) Equalizers compensate attenuation  
(c) They can improve the eye diagram  
(d) Both (a) and (c) are true.
- (vii) In QAM,  
(a) both frequency and phases are modulated simultaneously  
(b) both amplitude and frequency are modulated together  
(c) both amplitude and phase are modulated together  
(d) none is true.
- (viii) Rake receivers are employed to take care of  
(a) amplitude variations (b) time-jitter  
(c) BER (d) none is true.
- (ix) In the OFDM transmitter, the IFFT stage is required  
(a) before the modulator (b) after the modulator  
(c) any where (d) IFFT is not required.
- (x) The FHSS is used by  
(a) CDMA cellular system (b) Bluetooth systems  
(c) WLANs (d) None of (a), (b) & (c).

### 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) Why does ISI occur in RF communication? Show mathematically how the factor responsible for ISI is generated in a receiver. Explain the operation of an equivalent transmission model with an equalizer. [[CO4](Analyse/HOCQ)]  
(b) Explain the operation of a Linear Adaptive Equalizer with a block diagram (for 3 stages). What is the function of the equalizer coefficients? [[CO4](Understand/IOCQ)]  
**(1 + 4 + 3) + 4 = 12**

### Group - C

4. (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](Analyse/HOCQ)]  
**4 + 5 + 3 = 12**

5. (a) QAM involves modulation of both carrier amplitude and carrier phase. Explain. Draw the constellation diagrams for (i) 16-AM/PM and (ii) 16-QAM modulation schemes. [[CO2](Understand/IOCQ)]
- (b) Why does the ERFC term contain Complementary word? Show how the probability of error is related to  $(E_s / N_0)$  with the help of a suitable graph. [[CO2](Understand/IOCQ)]
- (2 + 5) + (1 + 4) = 12**

### Group - D

6. (a) Prove the relationship:  $B \approx [C/1.44 \gamma]$ , where B = bandwidth and C = channel data capacity. Hence, show that C can be increased increasing B, even though SNR is small. [[CO3](Analyse/IOCQ)]
- (b) What is Gold sequence? Why is it important? Draw and explain the generator circuit for a Gold sequence of length  $(2^6 - 1)$ . [[CO3](Understand/IOCQ)]
- (4 + 2) + (1 + 1 + 4) = 12**
7. (a) How does slotted ALOHA work? [[CO1](Remember/LOCQ)]
- (b) MAI limit number of CDMA users. Justify your answer. [[CO3](Understand/LOCQ)]
- (c) Why does Bluetooth use ISM band? What are the limitations of Bluetooth? Differentiate between piconet and scatternet. [[CO1](Analyse/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.
- $$G = \begin{bmatrix} 100110 \\ 010011 \\ 001111 \end{bmatrix} \quad \text{[[CO5](Analyse/HOCQ)]}$$
- 3 + 3 + 6 = 12**
9. (a) What is the function of Estimation in communication? Explain. [[CO4](Remember/LOCQ)]
- (b) What are the differences between linear and non-linear estimation? Give examples of each and their application areas. [[CO4](Understand/LOCQ)]
- (c) Why is maximum likelihood decision critical in digital communication? [[CO4](Analyse/IOCQ)]
- 4 + 5 + 3 = 12**

<i>Cognition Level</i>	<i>LOCQ</i>	<i>IOCQ</i>	<i>HOCQ</i>
<i>Percentage distribution</i>	<i>25</i>	<i>54.17</i>	<i>20.83</i>

**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.*