Seat No.: ________   Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– VI (New) EXAMINATION – WINTER 2019

Subject Code: 2161001 **Date: 04/12/2019**

Subject Name: Digital Communication

Time: 02:30 PM TO 05:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

			MARKS
Q.1	**(a)**	List the advantages of digital communication over analog communication.	**03**
	(b)	Explain companding process in PCM and state the different laws for companding.	**04**
	(c)	With the help of neat diagram explain the transmitter and receiver of Pulse Code Modulation.	**07**
Q.2	**(a)**	Define for a random variable i. Mean square ii. Variance iii. Standard deviation	**03**
	(b)	Explain the effect of slope overloading in delta modulation.	**04**
	(c)	A zero memory source emits six messages with probabilities 0.3, 0.25, 0.15, 0.12, 0.1 and 0.08. Find the 4-ary (quaternary) Huffman-Code. Determine its average world length, the efficiency and the redundancy.	**07**
		OR	
	(c)	A zero memory source emits messages m_1 and m_2 with probabilities 0.8 and 0.2 respectively. Find the optimum (Huffman) binary code for this source as well as for its second and third order extensions. Determine the code efficiencies in each case.	**07**
Q.3	**(a)**	Which are the ideal requirements for the line coding?	**03**
	(b)	Consider shuffling a deck of cards and drawing one. Suppose that the card is black. (a) What is the probability that the card is the 4 of clubs? (b) What is the probability that the card is a face card (J, Q or K)? (c) What is the probability that the card is a spade? (d) What is the probability that the card is a 4, 5, or 6?	**04**
	(c)	Probability density function of a Random variable X is defined as : $f_X(x) = \begin{cases} kx^2 & ; \ 1 \le x \le 2 \\ kx & ; \ 2 < x \le 3 \\ 0 & ; \ \text{otherwise} \end{cases}$ Find: i Constant k; ii. P (X > 2), P (X ≤ 2), $P\left(\frac{1}{2} < X \le \frac{3}{2}\right)$; iii. Find Cumulative Distribution Function (CDF).	**07**
		OR	
	(a)	i. Why pulse shaping is required? ii. What is Inter Symbol Interference?	**03**
	(b)	Consider a binary code with 6 bits in each code word. Suppose that the probability of a bit being zero is 0.7, independent of the values of any other bit. i. What is the probability of the code word 001111 occurring? ii. What is the probability that a code word contains exactly four ones? iii. What is the probability that a code word contains 3 ones and 3 zeros?	**04**
	(c)	Random variable X is distributed with the following pdf: $f_X(u) = \begin{cases} \sin(x) & 0 \le x \le A \\ 0 & otherwise \end{cases}$ i. What is the value of the constant A?	**07**

ii. What is the corresponding CDF, $F_X(c)$?
iii. What is $E[X]$?
iv. What is Var(X)?

Q.4 **(a)** What is Eye diagram? Explain the significance of it in the pulse detection technique. **03**

(b) Justify "For finite signal and noise powers, the channel capacity always remains finite" **04**

(c) Explain non-coherent detection of Amplitude-Shift keying (ASK) signal with necessary equations. **07**

OR

Q.4 **(a)** Differentiate between Coherent and Non Coherent detection. **03**

(b) Explain an M-ary FSK digital modulation technique in brief. **04**

(c) Explain the operation of BPSK transmitter and receiver. **07**

Q.5 **(a)** What is Entropy? Explain in brief. **03**

(b) Suppose that X is a random variable whose entropy H(X) is 8 bits and Y (X) is a deterministic function that takes on a different value for each value of X. **04**

i. What is H(Y), the entropy of Y?
ii. What is H(Y |X), the conditional entropy of Y given X?
iii. What is H(X|Y), the conditional entropy of X given Y ?
iv. What is H(X, Y), the joint entropy of X and Y?

(c) Consider a (5,1) linear block code defined by the generator matrix **07**

$\boldsymbol{G} = [\mathbf{1\ 1\ 1\ 1\ 1}]$

i. Find the parity check matrix H of the code in systematic form.
ii. Find the encoding table for the linear block code.
iii. What is the minimum distance $\boldsymbol{d_{min}}$ of the code? How many errors can the code detect? How many errors can the code correct?
iv. Find the decoding table for the linear block code (Consider single bit errors only).
v. Suppose $\boldsymbol{c} = [\mathbf{1\ 1\ 1\ 1\ 1}]$ is sent and $\boldsymbol{r} = [\mathbf{0\ 1\ 1\ 1\ 1}]$ is received. Show how the code can correct this error.

OR

Q.5 **(a)** What is Burst error? Explain Burst error correction. **03**

(b) Consider the generator polynomial for a (7,3) cyclic code defined by **04**

$\boldsymbol{g(p) = p^4 + p^3 + p^2 + 1}$

i. Find the encoding table for the cyclic code.
ii. What is the minimum distance $\boldsymbol{d_{min}}$ of the code?

(c) Consider a binary symmetric communication channel, whose input source is the alphabet X = {0, 1} with probabilities {0.5, 0.5}; whose output alphabet is Y = {0, 1}; and whose channel matrix is **07**

$$\begin{array}{cc} & \quad \boldsymbol{y_1} \qquad \boldsymbol{y_2} \ \rightarrow \text{outputs} \\ \text{inputs} \rightarrow \begin{array}{c}\boldsymbol{x_1}\\ \boldsymbol{x_2}\end{array} & \begin{bmatrix} \mathbf{1}-\boldsymbol{\epsilon} & \boldsymbol{\epsilon} \\ \boldsymbol{\epsilon} & \mathbf{1}-\boldsymbol{\epsilon} \end{bmatrix} \end{array}$$

where $\boldsymbol{\epsilon}$ is the probability of transmission error.

i. What is the entropy of the source, H(X)?
ii. What are the probability distribution of the outputs p(Y), and the entropy of this output distribution, H(Y)?
iii. What is the joint probability distribution for the source and the output, p(X, Y), and what is the joint entropy, H(X, Y)?
iv. What is the mutual information of this channel, I(X; Y)?

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