Reg No.:_______________ Name:_______________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (S, FE) / S6 (PT) (S, FE) Examination December 2024 (2019 Scheme)

Course Code: ECT306

Course Name: INFORMATION THEORY AND CODING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks. Marks

1	Define the term entropy of a discrete memory-less source. Calculate the entropy of a DMS with two symbols with respective probabilities $\{\frac{1}{2}, \frac{1}{2}\}$.	(3)
2	Differentiate between source coding and channel coding	(3)
3	State Shannon's channel coding theorem	(3)
4	What is meant by the differential entropy? Derive an expression for the same	(3)
5	Evaluate the expression $\left\{\frac{((2-4)\times 4)}{3}\right\}$ over the prime field modulo-5 operation	(3)
6	Differentiate between block codes and convolutional codes.	(3)
7	Elaborate on the features of cyclic codes and their benefits.	(3)
8	Explain the parameters of Hamming codes	(3)
9	Draw the convolutional encoder whose connection vectors are, g_1=(111) and g_2=(101).	(3)
10	Explain the features of any one 'capacity approaching' code.	(3)

PART B

Answer one full question from each module, each carries 14 marks.

Module I

11 a) Determine the mutual information between two discrete memoryless sources X and Y with conditional probability matrix given by (7)

$$P(Y/X) = \begin{bmatrix} 0.5 & 0.5 & 0 \\ 0.5 & 0 & 0.5 \\ 0 & 0.5 & 0.5 \end{bmatrix}$$

Verify the formula H(X,Y)= H(X) + H(Y/X). Given $p(x_1)$=0.6, $p(x_2)$=0.3 & $p(x_3)$=0.1.

b) For any discrete memoryless source S= $\{s_1, s_2, s_3, \ldots s_q\}$, prove that $0 \le H(S) \le \log_2 q$, where H(S) is the entropy of the source. (7)

OR

12 a) Consider a DMS with source probabilities {0.35, 0.25, 0.2, 0.15, 0.05} (10)

i. Determine the binary Huffman code for this source

ii. Determine the ternary Huffman code for this source using symbols A, B and C.

iii. Determine the average code word length and compare.

b) A given source alphabet consists of 300 words, of which 15 occur with probability 0.06 each and the remaining words occur with probability 0.00035 each. If 1000 words are transmitted each second, what is the average rate of information transmission? (4)

Module II

13 a) A binary channel has the following noise characteristics: (7)

$$P(Y/X) = \begin{bmatrix} 3/4 & 1/4 \\ 1/4 & 3/4 \end{bmatrix}$$

Find the channel capacity, efficiency and redundancy of the channel, if the source symbols are occurred with probabilities $p(x_1) = 2/3$ and $p(x_2) = 1/3$.

b) State and derive Shannon-Hartley theorem (7)

OR

14 a) A communication system employs a continuous source. The channel noise is white and Gaussian. The bandwidth of the source output is 10 MHz and signal to noise power ratio at the receiver is 100. (7)

i. Determine the channel capacity

ii. If the SNR drops to 10, how much bandwidth is needed to achieve the same channel capacity?

b) Find the capacity of a channel with infinite bandwidth. Discuss Shannon's limit (7)

Module III

15 a) Consider a systematic block code whose parity check equations are: (10)

$$p_1 = m_1+m_2+m_4$$

$$p_2 = m_1+m_3+m_4$$

$$p_3 = m_1+m_2+m_3$$

$$p_4 = m_2+m_3+m_4$$

i. Construct the G and H matrices for this code

ii. How many errors can the code detect and correct?

iii. Is the vector 10101010 a valid codeword?

iv. Is the vector 01011100 a valid codeword?

b) Which among the following block codes are perfect codes? Justify your answer. (4)

i. (7,3)

ii. (7,4)

OR

16 a) The parity check matrix for a (7,4) LBC is given below: (7)

$$P = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix}$$

Draw the syndrome calculator circuit for the code.

b) Explain the standard array decoding of linear block code. Derive the standard array for a (5,1) repetition code. (7)

Module IV

17 a) Encode the message 101 in systematic form for a cyclic code with generator polynomial $g(X) = 1 + X + X^2 + X^4$. (5)

b) Design a feedback shift register encoder for an (8,5) cyclic code with generator polynomial $g(X) = 1 + X + X^2 + X^3$. Use the encoder to find the codeword for the message 10101 in systematic form. (9)

OR

18 a) Consider the generator polynomial of (7,4) cyclic code as $g(X) = 1+X^2+X^3$. (8)

i. Determine the parity check polynomial for this code

ii. Find the generator and parity check matrices in systematic form

iii. Determine the error detecting and correcting capability of the code.

b) A (15,5) cyclic code has a generator polynomial as follows: (6)

$g(X) = 1 + X + X^2 + X^5 + X^8 + X^{10}$.

i. Find the code polynomial for the message 10101

ii. Has any error occurred during transmission for the received word 100010101000001?

Module V

19 a) Draw the state, tree and trellis diagram for the K=3, rate 1/3 code generated by, (14)

$g_1(X) = X+X^2$

$g_2(X) = 1+ X$

$g_3(X) = 1+ X+X^2$

OR

20 a) Explain decoding of convolutional codes using Viterbi algorithm. (14)

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