Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R,S) / S6 (PT) / (WP) Exam April 2025 (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	State the properties of entropy.	(3)
2	Explain the necessary and sufficient condition for a code to be instantaneous.	(3)
3	Is there any limit to the capacity of AWGN channel if you can increase its bandwidth B in Hertz without limit, but while not changing noise and signal power? If so, what is that limit?	(3)
4	Define differential entropy.	(3)
5	Distinguish between hamming distance and minimum distance of a linear block code.	(3)
6	List the properties of a finite filed.	(3)
7	For the (7,4) single error correcting cyclic code,generator polynomial $g(x)=1+x+x^3$. Generate the non systematic cyclic code for the message[1001].	(3)
8	Explain the various parameter of a BCH code.	(3)
9	For a Convolutional encoder, the generator sequences are given as, g(1) = (1,1,1) and g(2) = (1,0,1).Draw the encoder circuit.	(3)
10	Define constraint length and rate of a convolutional code.	(3)

PART B

Answer onefull question from each module, each carries 14 marks.

Module I

11 a) Consider two sources X and Y with joint probability distribution, P(X,Y) given as (7)

$$P(X,Y) = \begin{bmatrix} 0.05 & 0 & 0.20 & 0.05 \\ 0 & 0.10 & 0.10 & 0 \\ 0 & 0 & 0.2 & 0 & 0.10 \\ 0.05 & 0.05 & 0 & 0.10 \end{bmatrix}$$

Compute H(x),H(y),H(x,y),H(x/y),H(y/x) and I(x,y).

b) Derive the expression for a mutual information I(x,y). (7)

OR

12 a) Prove that the entropy of a discrete memory less source S is upper bounded by average code word length L for any distortion less source encoding scheme. (7)

b) Given the messages A, B, C, D, E and F with respective probabilities of 0.4, 0.2, 0.2, 0.1, 0.07 and 0.03. Construct a binary code by applying Huffman encoding procedure. (7)

Module II

13 a) Explain Binary Symmetric Channel and derive its channel capacity. (7)

b) A CRT terminal is used to enter alphanumeric data in to a computer.The CRT is connected through a voice grade telephone line having a usable BW of 3 KHz and an output SNR of 10 dB.Assume that the terminal has 128 characters and data is sent in an independent manner with equal probability (7)

i)Find average information per character

ii)Find capacity of channel

iii)Findmaximum rate at which data can be sent from terminal to the computer without error

OR

14 a) A binary symmetric channel has the following noise matrix with source probabilities P(x1)=2/3 and P(x2)= 1/3. $P(y/x) = \begin{bmatrix} 3/4 & 1/4 \\ 1/4 & 3/4 \end{bmatrix}$ (7)

i)Determine H(x),H(y),H(x,y),H(y/x),H(x/y) and I(x,y).

ii)Finad channel capacity.

b) Explain Bandwidth-efficiency relation and Shannon's Limit of a continuous Gaussian channel. (7)

Module III

15 a) For a systematic (7,4) linear block code, the parity matrix P is given by (7)

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

i. Find the code vectors corresponding to the message vectors [110].

ii. Draw the encoder circuit.

iii. A single error has occurred in the following received vector [110010]. Detect and correct the received vector.

b) Consider a (7,4) linear code whose generator matrix is (7)

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

i)Draw the encoder circuit.

ii)Draw the syndrome calculation circuit.

OR

16 a) The parity bits of a (8,4) linear systematic block code are generated by (7)

c5 = d1+d2+d4

c6=d1+d2+d3

c7=d1+d3+d4

c8=d2+d3+d4

(+ sign denotes modulo-2 addition)

where d1, d2, d3 and d4 are message bits and c5, c6, c7 and c8 are parity bits.

i)Find generator matrix G and parity check matrix H for this code.

ii) Find the minimum weight of this code.

b) Define standard array. How is it used in syndrome decoding? Explain with an (7)

example.

Module IV

17 a) Design an encoder circuit for the (7,4) binary cyclic code generated by $g(x)= 1+x+x^3$ and verify its operation using the message vector [1011]. (7)

b) Explain the encoding and decoding of Hamming codes (7)

OR

18 a) For a (7,4) binary cyclic code ,the received vector z(x) is [1110101] and the generator polynomial is $g(x)= 1+x+x^3$ .Draw the syndrome calculation circuit and correct the single error in the received vector. (7)

b) Write the characteristics RS code. (7)

Module V

19 a) Draw the state diagram for a (2,1,1) convolutional encoder with generator sequence, g(1) = (1 1), g(2) = (1 0) and find the encoded output produced by the message sequence[10111]. (7)

b) Explain maximum likelihood decoding of convolutional codes. (7)

OR

20 a) Consider the (3,1,2) convolutional code with g(1)=[110],g(2)=[101] and g(3)=[111] (7)

(i)Find Transfer Function matrix

(ii)Find the code word corresponding to the information sequence [11101] using transform domain approach

b) i) Explain the concept of Tanner graph in LDPC Code with an example (7)

ii) Explain the Message-passing decoding scheme for LDPC codes with an example

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