Reg No.:______________ Name:______________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R,S) (FT/WP/PT) Examinations April 2026 (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 | Explain about prefix-free codes. Give an example | (3) |
| 2 | Find the information associated with the rolling of a fair dice | (3) |
| 3 | State channel encoding theorem (both achievability and converse) | (3) |
| 4 | Define Shannon's Limit. Explain its significance | (3) |
| 5 | Define hamming distance in the context of linear block codes | (3) |
| 6 | Explain Abelian group | (3) |
| 7 | Explain the term syndrome decoding in the context of cyclic codes | (3) |
| 8 | Explain the features of BCH code | (3) |
| 9 | How convolutional code is different from linear block code | (3) |
| 10 | Explain the need for flushing bits in Convolutional encoder | (3) |

### PART B
*Answer one full question from each module, each carries 14 marks.*

#### Module I

| | | | |
|---|---|---|---|
| 11 | a) | State and prove Kraft's inequality | (7) |
| | b) | Construct Huffman coding for a DMS with 6 symbols with probabilities {0.3, 0.25, 0.2, 0.12, 0.08, 0.05}. Find its code efficiency. | (7) |

**OR**

| | | | |
|---|---|---|---|
| 12 | a) | Define mutual information. Prove any two properties of mutual information | (7) |
| | b) | Consider two sources which emits messages $x_1,x_2,x_3$ and $y_1,y_2,y_3$ respectively with joint probability matrix given by | (7) |

$$P(X,Y) = \begin{bmatrix} \frac{3}{40} & \frac{1}{40} & \frac{1}{40} \\ \frac{1}{20} & \frac{3}{20} & \frac{1}{20} \\ \frac{1}{8} & \frac{1}{8} & \frac{3}{8} \end{bmatrix}$$. Calculate H(X), H(Y), H(X/Y) and H(Y/X)

**Module II**

13 a) Derive the channel capacity of binary erasure channel for the probability of erasure, $\alpha$ (7)

b) An analog signal having 4KkHz bandwidth is sampled at 1.25 times the Nyquist rate and each sample is quantized to one of 256 equally likely levels. Assuming samples to be statistically independent (7)

(i) What is the information rate of the source

(ii) Can output of this source transmitted without error over an AWGN channel with a bandwidth of 10kHz and SNR of 20dB.

(iii) Find SNR required for an AWGN channel for error free transmission of part (ii).

(iv) Find the bandwidth required for an AWGN channel for an error free transmission of output of this source if SNR is 20dB

**OR**

14 a) State and prove Shannon's information capacity theorem (7)

b) Derive the capacity of infinite bandwidth channel (7)

**Module III**

15 a) For a (6,3) systematic block code, the relation between parity bits and message bits are given by (7)

$P_1 = m_1 + m_2$ , $P_2 = m_1 + m_3$ , $P_3 = m_2 + m_3$

Find (i) the parity check matrix (ii) generator matrix (iii) all possible code words

b) Distinguish between integral domain and division ring with example (7)

**OR**

16 a) A systematic (6, 3) block code has the generator matrix given below. (7)

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

(i) Construct the standard array and determine the syndromes of correctable error patterns (ii) Decode the received code vector [101110] with the help of standard array.

b) Explain the properties of (i) Commutative Ring (ii) Field. (7)

**Module IV**

17 a) The generator polynomial for (7,4) cyclic code is $X^3+X+1$. Find the systematic cyclic code word for the following message sequences (i) 1010 (ii) 1101 (7)

b) Design encoder and syndrome calculator circuits for (7, 4) systematic cyclic code with generator polynomial $g(X) = X^3+X^2+1$. (7)

**OR**

18 a) State and prove the properties of syndrome polynomials in the context of cyclic codes (7)

b) Find the generator matrix corresponding to the (7,4) cyclic code with generator polynomial $g(X) = X^3+X+1$ (7)

**Module V**

19 a) A rate 1/3 convolutional encoder having generating sequence $g^{(1)} = (100)$, $g^{(2)} = (111)$ and $g^{(3)} = (101)$. (14)

(i) Draw the encoder.

(ii) Find the output code for the message sequence [1011] using the trellis diagram.

**OR**

20 A (3, 1, 2) convolutional code is described by $g^{(1)} = [100]$, $g^{(2)} = [111]$, $g^{(3)} = [101]$. (14)

(i) Draw the encoder

(ii) Draw the state diagram

(iii) Using Viterbi algorithm, decode the received sequence,

r = [101 110 101 010 101 110 011]

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