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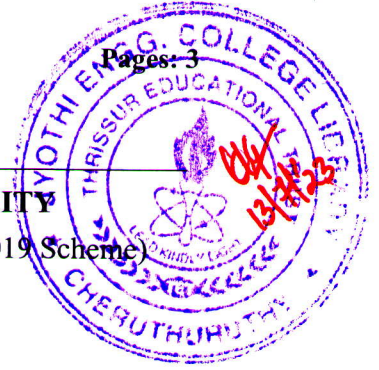
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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S6 (R, S) / S6 (PT) (R) Examination June 2023 (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 | Consider a source $S = \{S_1, S_2, S_3\}$ with $P = \{1/2, 1/4, 1/4\}$. Find self-information of each message and entropy of source S ? | (3) |
| 2 | Define coding and explain the necessity of coding? | (3) |
| 3 | State the positive and negative statements of Shannon's channel coding theorem. | (3) |
| 4 | Explain BSC with its channel diagram. | (3) |
| 5 | Distinguish between block codes and convolutional codes. | (3) |
| 6 | Explain how generator matrix is obtained for a linear block code. | (3) |
| 7 | What is BCH code? | (3) |
| 8 | List any three properties of cyclic code. | (3) |
| 9 | For a (2,1,2) convolutional encoder with impulse response $g(1)=[111]$ and $g(2)=[101]$, find the output sequence for the message $D=1\ 0\ 0\ 1\ 1$ by time domain approach. | (3) |
| 10 | Explain trellis diagram. | (3) |

PART B

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

Module I

- 11 a) Show that $H(X, Y) = H(X/Y) + H(Y)$. (7)
- b) Given the messages X_1, X_2, X_3, X_4, X_5 and X_6 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. Also determine its efficiency and redundancy. (7)

OR

- 12 a) Construct an instantaneous binary code for a source producing 5 symbols S_1 to S_5 with respective probabilities of $\{1/2, 1/6, 1/6, 1/9, 1/18\}$. Also find the code efficiency and redundancy? (7)

- b) The joint probability of a pair of random variable is given below. Determine $H(X)$, $H(Y)$, $H(X,Y)$, $H(X/Y)$, $H(Y/X)$ and $I(X,Y)$. Verify the relation between joint, conditional and marginal entropies? $P(X,Y) = \begin{bmatrix} 1/3 & 1/3 \\ 0 & 1/3 \end{bmatrix}$ (7)

Module II

- 13 a) Explain Bandwidth-efficiency relation and Shannon's Limit of a continuous Gaussian channel. (7)
- b) A message source produces two independent symbols A and B with probabilities $P(A)=0.4$ and $P(B)=0.6$ and transmitted through a BSC. Calculate the Information transmission rate of the system if the symbols are received in average with 4 in every 100 symbols in error. (7)

OR

- 14 a) Calculate the capacity of a Gaussian channel with a bandwidth of 1MHz and S/N ratio of 30dB. (7)
- b) Explain Binary Erasure Channel and derive its channel capacity. (7)

Module III

- 15 a) Construct the encoding circuit of a systematic (6,3) LBC with the parity matrix given by $P = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{bmatrix}$ (7)

Also find all possible code vectors.

- b) Explain the error detection and correction capabilities of linear block code. (7)

OR

- 16 a) Explain the procedure to prepare the standard array of LBC. Also construct the standard array of (4,2) LBC whose parity matrix is given by, $P = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$ (7)
- b) For a systematic (7,4) linear block code, the parity matrix P is given by, (7)

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

A single error has occurred in the received vectors [0111110] and [1011100].

Detect and correct the error?

Also draw the syndrome calculation circuit?

Module IV

- 17 a) Draw the general encoding circuit for (n,k) cyclic code and explain its operation. (7)
b) Find the generator and parity check matrices of $(7,4)$ cyclic code where (7)
 $x^n+1 = x^7+1 = (1+x+x^3)(1+x+x^2+x^4)$.

OR

- 18 For a $(7,4)$ 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 explain the procedure with the register contents. Also correct the single error in the received vector. (14)

Module V

- 19 Consider a $(3,1,2)$ convolutional code with $g^{(1)}=(1\ 1\ 0)$, $g^{(2)}=(1\ 0\ 1)$ and $g^{(3)}=(1\ 1\ 1)$. (14)
i) Draw the encoder block diagram.
ii) Find the generator matrix.
iii) Find the code vector corresponding to the information sequence $(1\ 1\ 1\ 0\ 1)$ using time domain and transfer domain approach.

OR

- 20 Explain Viterbi algorithm for decoding of convolutional code with example with the help of figure. (14)
