Register No.: .... Name: ....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (R), MAY 2023
ELECTRONICS AND COMMUNICATION ENGINEERING
(2020 SCHEME)

Course Code : **20ECT306**

Course Name: **Information Theory and Coding**

Max. Marks : **100** **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Elaborate on amount of information with mathematical expression.
2. Comment on uniquely decodable code with an example.
3. Sketch and explain binary erasure channel.
4. Explain differential entropy.
5. With an example define groups.
6. List the properties of linear block codes.
7. Explain BCH codes.
8. List the significance of generator polynomial in cyclic codes.
9. Define LDPC codes. List the importance of LDPC codes.
10. With necessary illustrations explain Viterbi algorithm.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) State and prove Kraft's inequality. (7)

b) Determine the Huffman coding for the following message with their probabilities given p(A) = 0.15, p(B) = 0.25, p(C) = 0.2, p(D) = 0.02, p(E) = 0.1, p(F) = 0.08, p(G) = 0.2. Find the efficiency and redundancy of the code. (7)

OR

12. a) A source emits one of three symbols X1, X2, X3 with probabilities 1/4, 1/4, 1/2 respectively. The successive symbols emitted by the source are statistically independent. Calculate the entropy of the source. (4)

b) If X and Y are discrete random sources and P(X, Y) is their joint probability matrix and is given below. Compute marginal entropy, conditional entropy and joint entropy also verify their relation. (10)

$$P(X, Y) = \begin{matrix} 0.08 & 0.05 & 0.02 & 0.05 \\ 0.15 & 0.07 & 0.01 & 0.12 \\ 0.10 & 0.06 & 0.05 & 0.04 \\ 0.01 & 0.12 & 0.01 & 0.06 \end{matrix}$$

MODULE II

13. a) State and derive Shannon-Hartley theorem. Explain the implications. (8)

b) A communication system employs a continuous source. The channel noise is white Gaussian. The bandwidth of the source output is 10 MHz and signal to noise power ratio at the receiver is 100. (6)
(i) Determine the channel capacity.
(ii) If the signal to noise ratio drops to 10, how much bandwidth is needed to achieve the same channel capacity as in case (i).

OR

14. a) Derive the relation between differential entropy and entropy. (8)

b) A continuous random variable, X is uniformly distributed in the interval (0, 4). Find the differential entropy H(X). Suppose that X is a voltage which is applied to an amplifier whose gain is 7. Find the differential entropy of the output of the amplifier. (6)

MODULE III

15. a) Explain about ring and field. List any three properties of each. (6)

b) The parity matrix of a (6,3) linear systematic block code is given $P = \begin{matrix} 1 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \end{matrix}$ Find all the possible code vectors. Also calculate minimum distance of the code. How many errors can be detected and corrected by this code. (8)

OR

16. Explain about standard array formation and decoding with an example. (14)

MODULE IV

17. a) Explain about cyclic codes and the procedure to generate code word and an encoder circuit. (6)

b) Find the coded word for the message 1101 in (7,4) cyclic code in systematic form given $g(x) = x^3 + x + 1$. Also sketch the encoder circuit. (8)

OR

18. a) Consider the (31, 15) Reed Solomon code. (6)

(i) How many bits are there in a symbol of the code.

(ii) What is the block length in bits.

(iii) What is the minimum distance of the code

(iv) How many symbols in error can the code correct.

b) Given a message word [1001]. Find out its corresponding coded word in (7,4) Hamming code. (8)

MODULE V

19. a) Consider (3, 1, 2) convolution code with (9)

$g^{(1)} = (1\ 1\ 0)$, $g^{(2)} = (1\ 0\ 1)$, $g^{(3)} = (111)$:

(i) Draw the encoder block diagram

(ii) Find the generator matrix

(iii) Find the code word corresponding to the information sequence (11101) using time domain approach.

b) Explain about the steps in encoding of LDPC codes. (5)

OR

20. Draw a (2, 1, 2) convolutional encoder with the feedback polynomials as $g^1(x)=1+x+x^2$ and $g^2(x)= 1+ x^2$. Draw Trellis and find the output sequence for an input sequence [1 0 0 1 1]. Perform Viterbi decoding on this trellis for the received sequence {01, 10, 10, 11, 01, 01, 11}. (14)

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