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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SIXTH SEMESTER B. TECH DEGREE EXAMINATION (R,S), MAY 2024
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. Consider a telegraph source having two symbols, dot and dash. The dot duration is 0.2s. The dash duration is 3 times the dot duration. The probability of the dot's occurring is twice that of the dash, and the time between symbols is 0.2s. Calculate the information rate of the telegraph source.
2. State and explain Kraft's inequality.
3. Find the entropy of the input X and output Y of an amplifier whose gain is 4 and the PDF of X is given by $f(x)=1/4$, $0 \leq x \leq 4$, over the interval (0,4).
4. State Shannon's second theorem on channel capacity. Give the Positive and Negative statements.
5. Describe the steps for preparing standard array.
6. Differentiate
   i. Systematic and non-systematic codes
   ii. Linear and non-linear codes.
7. List out the features of Reed Solomon code.
8. Explain the properties of Hamming codes.
9. Draw the encoder circuit of a (2, 1, 3) convolutional encoder, if the generator sequences are $g^{(1)}$ =(1 0 0 1) and $g^{(2)}$ = (1 1 0 1) respectively.
10. Explain the concept of Tanner graph in LDPC Code.

PART B

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

MODULE I

11. a) The source symbols and associated probabilities of a six symbol DMS source is as follows (7)

Symbols	X1	X2	X3	X4	X5	X6
Probabilities	0.4	0.2	0.2	0.1	0.07	0.03

Construct a binary Huffman code and determine the code efficiency.

b) Prove that $I(x,y) = H(x)+H(y)-H(x,y)$. (7)

OR

12. a) A transmitter has an alphabet consisting of 5 letters {a1,a2,a3,a4,a5} and the receiver has an alphabet consisting of 4 letters {b1,b2,b3,b4}. The joint probability of a system is given below

$$P(A,B) = \begin{bmatrix} 0.2 & 0 & 0.2 & 0 \\ 0.1 & 0.01 & 0.01 & 0.01 \\ 0 & 0.02 & 0.02 & 0 \\ 0.04 & 0.04 & 0.01 & 0.06 \\ 0 & 0.06 & 0.02 & 0.2 \end{bmatrix}$$ (14)

Calculate H(A), H(B), H(A,B), H(A/B), H(B/A), I(A,B).

MODULE II

13. a) State Shannon-Hartley theorem. Paraphrase on Bandwidth-SNR trade off and Shannon's limit. (10)

b) A Gaussian channel has a bandwidth of 4 KHz and a two-sided noise power spectral density (η/2) of 10^-14 watts/Hz. The signal power at the receiver has to be maintained at a level less than or equal to 0.1 milli watt. Calculate the capacity of the channel. (4)

OR

14. a) Derive the channel capacity of a Binary Symmetric Channel. (7)

b) A voice-grade channel of the telephone network has a bandwidth of 3.4 KHz. (7)

i) Calculate channel capacity of the telephone channel for a signal-to-noise ratio of 30dB.

ii) Calculate the minimum signal-to-noise ratio required to support information transmission through the telephone channel at the rate of 4800 bits/sec.

MODULE III

15. a) The parity check matrix of a particular (7, 4) linear code is given as:

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

(10)

(i) Find the Generator Matrix (G).
(ii) List all the code vectors.

b) Write notes on fields, also discuss the operation of fields. (4)

OR

16. a) For a linear (n,k) block code, prove that $CH^T=0$,where H is the parity check matrix and C the code matrix. (5)

b) For a systematic linear block code, the three parity check bits, c4, c5 and c6 are (9)

given by:

$$c_4 = d_1 \oplus d_2 \oplus d_3$$

$$c_5 = d_1 \oplus d_2$$

$$c_6 = d_1 \oplus d_3$$

i. Construct the Generator matrix.

ii. Decode the received code word 101100.

MODULE IV

17. a) The generator polynomial of a (7,4) Cyclic code is $G(p)=p^3+p+1$. Find the code vectors corresponding to the message vectors 1011 and 1101 in Non-Systematic form. (7)

b) Draw the encoder circuit for a (7,4) Cyclic code with $G(p)=p^3+p+1$ and obtain the codeword for the message sequence 1001. (7)

OR

18. a) For a (7,4) Cyclic code, the received vector Y is 1110101 and the generator polynomial is p^3+p+1. Draw the syndrome calculation circuit and correct the single error in the received vector. (10)

b) List out the properties of cyclic codes. (4)

MODULE V

19. a) Describe the Viterbi algorithm for convolution codes also write the procedure for decoding using Viterbi algorithm. (8)

b) Explain the message passing decoding scheme for LDPC Codes. (6)

OR

20. a) A convolutional encoder with 3 shift register stages and rate ½ is represented by the following generator polynomials: - $g_1(x) = 1+X+X^2$; $g_2(x) = X+X^2$. Draw the state and trellis diagram for the encoder. (14)

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