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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (S), AUGUST 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. Define mutual information. List its properties.
2. Illustrate instantaneous codes with an example, how can it be tested for?
3. Compute channel capacity of a binary symmetric channel with error probability $\frac{1}{4}$.
4. Illustrate bandwidth efficiency diagram.
5. Explain the properties of Galois field.
6. With an example demonstrate the syndrome decoding of a linear block code.
7. The generator polynomial for a cyclic code is $g(x) = 1 + x + x^3$. Find the generator matrix in systematic form.
8. Explain various parameters of R S codes. List out its applications.
9. Draw a (2, 1,3) convolutional encoder with [1, 0, 0, 1] and [1, 1, 0, 1] as the impulse responses.
10. Explain Tanner graph representation of LDPC codes.

PART B

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

MODULE I

11. a) A voice signal in a PCM system is sampled at 2.5 times the Nyquist rate and is quantized into 16 levels with the following probabilities: (7)
$p_1=p_2=p_3=p_4=0.08$
$p_5=p_6=p_7=p_8=0.065$
$p_9=p_{10}=p_{11}=p_{12}=0.055$
$p_{13}=p_{14}=p_{15}=p_{16}=0.05$.
Calculate the entropy and information rate of the PCM signal if the bandwidth of the signal is 3.5KHz.

b) Prove Krafts inequality. (7)

OR

12\. a) A discrete source emits 7 symbols with probabilities, 0.15, 0.24, 0.13, 0.26, 0.12, 0.02, and 0.08. Construct binary codes using Huffman algorithm. Compute the efficiency and redundancy of the code. (7)

b) Joint Probability Matrix (JPM)of a discrete channel is given below (7)

0.3	0.2	0.1
0.1	0.1	0.2

Determine different entropies and verify their relationships.

MODULE II

13\. a) Two symbols x1, x2 with probabilities P(x1) = 0.4 and P(x2) = 0.6 are transmitted through a discrete channel given below. (7)

$$P(Y/X)=\begin{matrix} 0.8 & 0.2 \\ 0.2 & 0.2 \end{matrix}$$

Identify the channel and calculate the capacity and the efficiency of the channel.

b) Derive the capacity of a Gaussian channel with bandwidth B and noise power spectral density N/2. Also, find the capacity when the bandwidth of the channel tends to infinity. (7)

OR

14\. a) Derive the expression for channel capacity of Binary Erasure Channel (BEC). (7)

b) A black and white television picture may be viewed as consisting of approximately $3X10^5$ elements, each one of which may occupy one of 10 distinct brightness levels with equal probability. Assume the rate of transmission is 30 picture frames per second and signal to noise ratio is 30dB. Calculate the minimum bandwidth required to support the transmission of resultant video signal. (7)

MODULE III

15\. a) Calculate GF (2^3) if the primitive polynomial is $1+x+x^3$. Represent field elements in polynomial form and n-tuple form. (7)

b) Parity matrix of a (7,4) systematic linear block code (LBC) is given as (7)

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

(i) Find the generator and parity check matrices.
(ii) Draw the syndrome calculation circuit.
(iii) Explain the decoding using the syndrome of a received vector [1101000].

OR

16. a) For a systematic (6,3) linear block code, the three parity check bits, c_4, c_5 and c_6 are given by: (8)

$C_4=d_1+d_2+d_3$

$C_5=d_1+d_2$

$C_6=d_1+d_3$

i Construct the Generator matrix
ii Find all the possible code vectors
iii Detect and correct the error in the received code word [1100 001] using standard array.

b) For a (5,2) LBC parity matrix is given by (6)

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

(i) Find the generator matrix and Parity check matrix.
(ii) Find d_{min} error detection and correction capability of the code.

MODULE IV

17. a) For a (7,4) cyclic code in systematic form with generator polynomial $1+x+x^3$ (7)

i) Find the codewords in systematic form corresponding to the message vectors (1110) and (1110).
ii) Find the generator matrix corresponding to the systematic cyclic code.
iii) Draw the encoder circuit and explain encoding of the message (1010).

b) With the help of a block diagram, explain the decoding of cyclic codes. (7)

OR

18. a) 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 correct the single error in the received vector. (7)

b) A (15,5) linear cyclic code has a generator polynomial $g(x)=1+x+x^2+x^4+x^5+x^8+x^{10}$. (7)

(i) Draw the block diagram of an encoder and syndrome calculator for this code.

(ii) Find the code polynomial for the message polynomial $D(x) = 1+x+x^4$.

(iii) Is $V(x) = 1+x^4+x^6+x^8+x^{14}$ a code polynomial?

MODULE V

19. a) For a convolutional encoder the generator polynomials are given by $g^{(1)} = [1,0,0]$, $g^{(2)} = [1,0,1]$ and $g^{(3)} = [1,1,0]$. (7)

i) Sketch the encoder configuration.

ii) Draw the state diagram and

iii) Determine the output for the input 1 1 0 1 0 1 0 0.

b) Explain the Message-passing decoding scheme for LDPC codes. (7)

OR

20. a) Draw the Trellis diagram of a (3,1,2) convolution encoder with $g^{(1)} = [1\ 0\ 1]$, $g^{(2)} = [1\ 1\ 0]$, $g^{(3)} = [1\ 1\ 1]$. (7)

b) A convolutional code is described by g1= [100], g2 = [101], g3 = [111]. Decode the transmitted sequence 101001011110111 using Viterbi decoding. (7)

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