BRAINWARE UNIVERSITY

Term End Examination 2024-2025
Programme – B.Tech.(RA)-2021
Course Name – Information Theory and Coding
Course Code - PEC-ECR702A
(Semester VII)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Identify the value of 1 nat:
a) 3.32 bits b) 1.32 bits
c) 1.44 bits d) 3.44 bits

(ii) If a source emits four symbols with equal probabilities, identify the value of entropy of the source
a) 2 bits b) 4 bits
c) 1 bit d) 0.5 bits

(iii) Shannon's Source Coding Theorem indicates that
a) Data cannot be compressed beyond entropy. b) Noiseless coding cannot exist.
c) Redundancy always decreases the code length. d) Channels with noise cannot transmit information.

(iv) Identify the correct statement for Huffman coding:
a) Huffman coding assigns the shortest code to the least probable symbol. b) Huffman coding is always fixed-length.
c) Huffman codes are prefix-free. d) Huffman coding increases the entropy of the sourc

(v) In Huffman coding, a tree is constructed by:
a) Merging the two least probable symbols at each step b) Merging the two most probable symbols at each step
c) Arranging symbols in alphabetical order d) Randomly pairing symbols

(vi) For a discrete random variable X with two possible outcomes, identify the maximum entropy.

a) 1 bit
b) 2 bits
c) 0.5 bits
d) Infinity

(vii) Identify the value of p for which the binary entropy function H(p) is maximum:

a) 0
b) 0.5
c) 1
d) Infinity

(viii) In a binary symmetric channel, determine the capacity if the error probability is 0.

a) 0 bits
b) 1 bit
c) 2 bits
d) Infinite

(ix) A linear block code can be described by:

a) A generator matrix
b) A modulation scheme
c) An error-correcting code
d) A signal power

(x) Identify the dimension of the generator matrix G for a(n,k) linear block code:

a) k*n matrix
b) n*n matrix
c) n*k matrix
d) k*k matrix

(xi) The code word of a linear block code is represented as:

a) c = mG
b) c = mH
c) c = m (G^-1)
d) c = G H

(xii) For a (7,4) linear block code, identify the number of message bits:

a) 3
b) 4
c) 7
d) 11

(xiii) In a BCH code, identify the length of the code word:

a) n = 2^m – 1
b) n = 2^m
c) n = 3^m – 1
d) n = m^2

(xiv) The minimal polynomial in BCH codes is expressed as:

a) The polynomial that defines the parity check matrix
b) The polynomial of lowest degree that has a given element as a root
c) The highest degree polynomial in the code
d) The generator polynomial for the code

(xv) The generator polynomial of a BCH code is indicated as:

a) The sum of all codewords
b) The least common multiple (LCM) of the minimal polynomials of its roots
c) The highest degree polynomial used for encoding
d) The polynomial used for the division algorithm

Group-B

(Short Answer Type Questions) 3 x 5=15

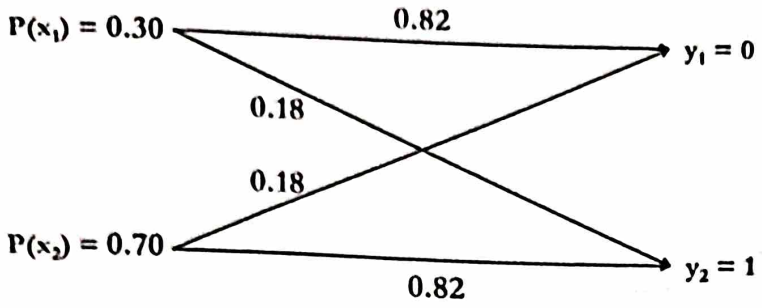
2. Illustrate properties of linear block code. (3)

3. Write down the steps involved in error correction for BCH codes. (3)

4. Illustrate properties of Information content. (3)

5. Define Rate of Information. (3)

6. Calculate the source entropy, and the capacity of the binary symmetric Channel (BSC) shown below. (3)



OR

A low pass channel has a suitable bandwidth of 3 KHz and S/N ratio of 20 dB at the channel output. Assuming white Gaussian Channel noise, calculate the capacity of the Channel. (3)

Group-C

(Long Answer Type Questions) 5 x 6=30

7. An internet service provider gives internet dial-up connection at 56 Kbps. If the telephone line provides a bandwidth of 3.5 KHz, calculate minimum SNR required in dB to support this. (5)

8. Explain the applications of Convolutional codes. (5)

9. Calculate the generator polynomial of a double error correcting BCH code with block length n = 15. (5)

10. Show that the generator polynomial g (x) of an (n, k) cyclic code is a factor of $1+x^n$. (5)

11. An analog signal is band limited to 4KHz and sampled at Nyquist rate. The samples are quantized into 4 levels having probabilities $P_A=1/8$, $P_B = 3/8$, $P_C = 3/8$, $P_D = 1/8$. Assuming that the quantization levels are independent, Calculate the information rate of the source. (5)

12. The generator matrix for a (6,3) block code is given below. Evaluate all the code vectors of this code. (5)

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

OR

The generator matrix for a (7,4) block code is given below. (5)

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

i. Evaluate the parity check matrix of this code
ii. Evaluate minimum weight of the code
iii. Compute the syndrome the received code word is 1101101.
iv. Evaluate the error correcting and detecting capabilities.

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