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Sub Code: NEC408

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B. TECH
(SEM. IV) THEORY EXAMINATION 2017-18
INFORMATION THEORY AND CODING

Time: 3 Hours

Total Marks: 100

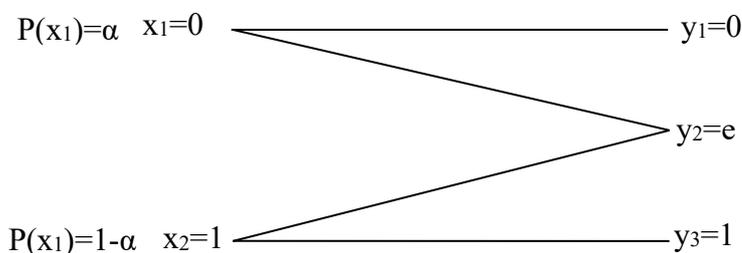
- Note:** 1. Attempt all Sections.
 2. Assume any missing data.

SECTION A

1. Attempt *all* questions in brief. 2 x 10 = 20
- What do you mean by Information Rate? Explain.
 - The probabilities of the five possible outcomes of an experiment are given as $P(x_1) = 1/2$, $P(x_2) = 1/4$, $P(x_3) = 1/8$, $P(x_4) = P(x_5) = 1/16$. Determine the entropy and information rate if there are 16 outcomes per second.
 - Explain Kraft's Inequality.
 - What are block codes? Explain.
 - What is channel matrix and channel diagram of BSC.
 - What is Binary Erasure Channel (BEC)?
 - Explain about error detection and correction capabilities of Hamming codes.
 - How does a single bit error differ from a burst error?
 - What are convolution codes? Explain.
 - Explain about BCH codes.

SECTION B

2. Attempt any *three* of the following: 10 x 3 = 30
- What is Mutual information? Explain its different properties. If there are M equally likely and independent symbols, then prove that amount of information carried by each symbol will be, $I(x_i) = N$ bits. (Where $M = 2^N$ and N is an integer)
 - A DMS X has six symbols x_1, x_2, x_3, x_4, x_5 & x_6 with probabilities $P(x_1) = 0.3$, $P(x_2) = 0.25$, $P(x_3) = 0.2$, $P(x_4) = 0.1$, $P(x_5) = 0.1$ & $P(x_6) = 0.05$. Construct a Huffman code for X and calculate the code efficiency.
 - Find the channel capacity of binary erasure channel of below figure.



- Write different methods of Error Detection. Explain with the help of suitable examples.
- Design a syndrome calculator for a (7,4) cyclic Hamming code generated by the polynomial $G(p) = p^2 + p + 1$. Calculate the syndrome for $Y = (1 \ 0 \ 0 \ 1 \ 1 \ 0 \ 1)$.

SECTION C

3. Attempt any one parts of the following: 10 x 1 = 10

- Define Entropy. Prove that the upper bound on the value of entropy H of a source is $\log_2 M$, where M is the number of symbols.
- What is Asymptotic Equipartition Property Theorem? Write consequences of AEP.

4. Attempt any one parts of the following: 10 x 1 = 10

- A DMS X has seven symbols with probabilities $P(x_1)=0.4$, $P(x_2)=0.2$, $P(x_3)=0.12$, $P(x_4)=0.08$, $P(x_5)=0.08$ & $P(x_6)=0.08$ & $P(x_7)=0.04$. Construct a Shannon- Fano code for X and calculate the code efficiency.
- Explain the need for source coding in communication system and discuss about compact code.

5. Attempt any one parts of the following: 10 x 1 = 10

- Explain different types of channels with their channel matrix and channel diagram.
- An analog signal of 4 kHz bandwidth is sampled at 1.25 times the Nyquist rate, and each sample is quantized into one of 256 equally likely levels. Assume that the successive samples are statistically independent.
 - What is the information rate of this source?
 - Can the output of this source be transmitted without error over an AWGN channel with a bandwidth of 10 kHz and an S/N ratio of 20dB?
 - Find the S/N ratio required for error free transmission for part (i).
 - Find the bandwidth required for an AWGN channel for the error free transmission of the output of this source if the S/N ratio is 20dB?

6. Attempt any one parts of the following: 10 x 1 = 10

- Given a (7,4) linear block code with the following parity check matrix H :

$$H = \left[\begin{array}{ccc|ccc} 1 & 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 \end{array} \right]$$

- Find the Generator matrix G .
- Find all code vectors.
- What will the minimum distance between code vectors?
- How many errors can be detected? How many errors can be corrected?

- Explain standard arrays and table look up for decoding.

7. Attempt any one parts of the following: 10 x 1 = 10

- Explain: (i) Golay Code and RS code. (ii) Burst error correcting codes.
- A (6,3) linear block code is generated according to the following generator matrix G :

$$G = \left[\begin{array}{ccc|ccc} 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 & 0 \end{array} \right]$$

For a particular code word transmitted, the received code word is 100011. Find the corresponding data word transmitted.