Dr Rakesh Sir 132 6/5/2023 18

National Institute of Technology Hamirpur, Hamirpur (H.P.)

End Semester Examination [B.Tech. 8th Semester]

EC-444

Information theory & Coding

Time Duration: 3 Hrs | Max. Marks 50 | Roll No : .....

Note:

All symbols used have their usual meanings.

Assume necessary data, if any.

Q1-Q6 are of 7 Marks each and Q7 is of 8 marks.

1. In a binary communication system (Figure 1), a 0 or 1 is transmitted. Because of channel noise, a 0 can be received as 1 and vice versa. Let m_0 and m_1 denote the events of transmitting 0 and 1, respectively. Let r_0 and r_1 denote the events of receiving 0 and 1, respectively. Let $P(m_0) = 0.5$, $P(r_1|m_0) = p = 0.1$, and $P(r_0|m_1) = q = 0.2$. Find $P(r_0)$ and $P(r_1)$. If a '1' was received, what is the probability that a '1' was sent? Calculate the probability of error P_e.

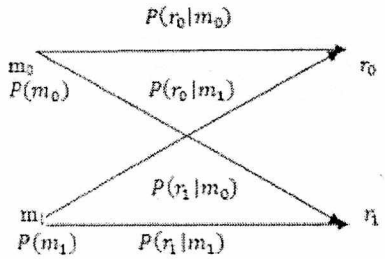

Figure 1

2. The generator polynomial of a $(9, 6)$ cyclic code is defined by

$$g(X) = 1 + X^3.$$

Develop encoder and decoder diagrams for this code, using a systematic form for the code. Verify the working of the circuits using a suitable example by assuming a message and received vector.

3. Consider parity matrix P for $(6, 3)$ Linear Block code as

$$P = \begin{pmatrix} 1 & 1 & 1 \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{pmatrix}.$$

Construct encoder and decoder for this Linear Block code. Comment and justify the code rate, error correction and detection capability of this $(6, 3)$ Linear Block Code.

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4. A convolutional coder has shift registers for the constraint length $K = 3$, two modulo-2 adders, and a multiplexer. The generator sequences of the encoder are as follows

$$g^{(1)} = \{1, 1, 0\},$$

$$g^{(2)} = \{1, 0, 1\}.$$

Draw the block diagram of the encoder. Explain its working & draw the trellis diagram for the same. Discuss Viterbi decoding algorithm for receiving 1000000100.. for an all zero transmitted code sequence.

5. The source of information X generates the symbols $\{x_1, x_2, x_3, x_4, x_5, x_6$ & $x_7\}$ with the corresponding probabilities $p(x_1) = 0.37, p(x_2) = 0.01, p(x_3) = 0.33, p(x_4) = 0.02, p(x_5) = 0.16, p(x_6) = 0.07, p(x_7) = 0.04\}$. Design the binary Huffman's encoding scheme. Calculate the coding efficiency.

6. The Z-channel has binary input and output alphabets and transition probabilities $p(y|x)$ given by

$$P(Y|X) = \begin{pmatrix} 1 & 0 \\ 1/2 & 1/2 \end{pmatrix},$$

with $x, y \in \{0, 1\}$ Find the capacity of the Z-channel and the maximizing input probability distribution.

7. Define and explain the following terms:

   (a) Maximum likelihood decoding

   (b) Syndrome polynomial

   (c) Information inequality

   (d) Kraft's inequality