Dr Ajay Kumar Malik - 3/12/2023

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National Institute of Technology, Hamirpur (HP)

Department of Computer Science and Engineering

Name of the Examination: End-Term Examination

Course Code: CS-722 | **Course Title:** Information Theory & Coding

Slot: DD | **Date of Exam: 03/12/2023**

Duration: 180 min | **Total Marks:** 50

Instructions:

1. Assume data wherever necessary.
2. Any assumptions made should be clearly stated.
3. Each answer should be completed with the final concluding remark wherever applicable.

1. **a)** Explain the objectives of the good error control coding schemes. Provide proper explaination for the assertions.

   b) Consider a Binary Erasure Channel (BEC), shown in Fig. 1 with 'e' as error and the transition probability matrix given by P = $\begin{bmatrix} \epsilon & 1-\epsilon & 0 \\ 0 & 1-\epsilon & \epsilon \end{bmatrix}$. Calculate the capacity of BEC when ϵ is empirically consider as i) 0.5, and ii) 0.3. Furthermore, find the ϵ value that can enable maximum capacity to the channel. **(5+5 M)**

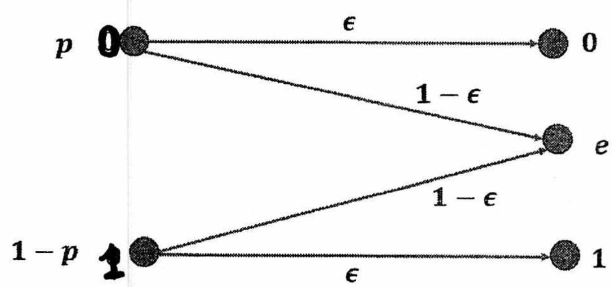

Fig1: Binary Erasure Channel.

2. For the given convolutional encoder with a shift register and ⊕ represents XOR gates as shown in Fig. 2. Consider a finite input message *i*= 11011110001, find the encoder data, tree code, constraint length, block length for convolutional code. **(10 M)**

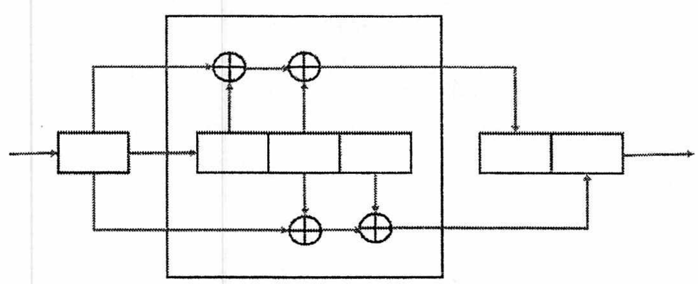

Fig2: Convolutional Encoder shift register.

3. a) Explain how a code can be represented as cyclic codes. Consider the given polynomials *f(x)* = $4 + 2x + x^2 + x^3 + 2x^4$ and *g(x)* = $3 + x^2 + 2x^4 + 2x^5$ *over Galois Field GF(2). Find the* codeword obtained after addition(+) and multiplication(.) of polynomials *f(x)* and *g(x).*

b) Consider the polynomial f(x) = x^2-1 in R_3 defined over GF(2) where R_3 id F(x)/(x^3 + 1) . Generate all the distinct cyclic codeword and find the minimum distance of the codeword.

(5+5 M)

4. Consider a discrete memoryless source with three possible symbols x_i, i= 1, 2, and 3 with corresponding probabilities as shown in Table 1. Find the efficiency using of the code using Huffman encoding algorithm when the symbols are grouped together two at a time. **(10 M)**

Table 1: *Symbols and the probablity*

Symbol	Probability
x_1	0.5
x_2	0.3
x_3	0.2

5. a). The basic idea behind error correcting codes is to add a certain amount of redundancy to the message prior to its transmission through the noisy channel. State the reason(s) behind the operations performed.

b) Illustrate two advantages and disadvantages of Linear Block Codes. Provide proper explanation for the assertions. **(5+5 M)**