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Sr. No.. 008704

Dec. 2023

B.Tech. (ECE) 7th SEMESTER

Error Correcting Codes (ECEL-709)

Time: 3 Hours | Max. Marks:75

Instructions:
1. *It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.*
2. *Answer any four questions from Part -B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

Assume relevant data/figure if found missing.

PART -A

Q1 (a) What are the objectives of good error control coding scheme? (1.5)

(b) "The syndrome depends only on the error pattern and not on the transmitted code word" . Justify the statement. (1.5)

(c) In a (5,4) cyclic code vector, how many numbers of invalid code words will be transmitted. What will be its code rate? (1.5)

(d) Show that for a linear block code the minimum hamming distance is equal to minimum weight of any non - zero codeword. (1.5)

(e) "For a code to be able to correct up to t errors, we must have minimum distance $d^* \geq 2t+1$". Justify the statement. (1.5)

(f) What do you mean by burst error. Using an example distinguish conventional multiple bits error and burst error. (1.5)

(g) Differentiate between Reed Solomon Code (RS) and Maximum Distance Separable (MDS) code (1.5)

(h) In convolution code encoder, why is the data entered from MSB side? (1.5)

(i) let in a convolution code: 4 is message bits, 3 are memory elements and 3 are modulo 2 adders, how many code bits will be transmitted by convolution encoder and what will be constraint length and tail of a convolution code? Give their significance. (1.5)

(j) What happens in a block code if more error occurs than its error correcting capability? (1.5)

PART B

Q2 (a) The parity check bits of a (8, 4) linear block code are given by,. (10)

$P_1 = m_1+m_2+m_3$

$P_2 = m_1+m_2+m_4$

$P3 = m_1+m_3+m_4$

$P_4 = m_2+m_3+m_4$

Where m_1, m_2 ,m_3 and m_4 are the message bits.

(a) Find the generator matrix and parity check matrix for this code.

(b) Find code vector for message bit 1101, 0011, 1001

(c) Find the minimum weight of this code.
(d) Find error detecting capabilities of this code.

(b) Show that codewords (0000, 1100, 0011, 1111) are linear codes. What is its minimum distance of these code word set. (5)

Q3 (a) Consider (7, 4) cyclic code defined by the generator polynomial $g(x) = 1 + x + x^3$. (10)
Obtain all code words in systematic form.
The code word 0111000 is sent over a noisy channel producing the received word 0101000, having a single error. Determine the syndrome polynomial S(x) for this received word and show that it is identical to the error polynomial e(x).

(b) Encode a binary word 11001 into the even parity hamming code. If a code has hamming distance of 7, how many errors can it detect and how many errors can it correct? (5)

Q4 (a) Design a convolution tree for 4 bit information message such that a convolution encoder has single shift register with two memory stages, 3 modulo 2 adders and one output multiplexer. The generator sequence of modulo 2 adders are as follows (10)

V1= (1 0 1)
V2= (1 1 0)
V3= (1 1 1)

Also design a convolution encoder.

(b) By taking an example, explain Viterbi algorithm for decoding of convolution code. (5)

Q5 (a) What are different ways to analyze the performance of different block codes. Explain code incurable error probability lower and upper bounds. How can performance of these codes be improved? (10)

(b) Differentiate between single and double dimensional parity check code. Explain error correction and detection correction capability of double dimensional parity code. (5)

Q6 (a) Generate all minimal polynomials and generator polynomial of BCH codes over $GF(2^3)$ for single and double error correction capability. (10)

(b) Differentiate between irreducible and primitive polynomial. What are the conditions for a polynomial to be irreducible and primitive both. Determine whether the following polynomial (5)
$p(x) = x^4 + x^3 + x + 1$ is irreducible and primitive over $GF(2^4)$

Q7 (a) Differentiate between single and double dimensional parity check code. Explain error correction and detection correction capability of both codes. (8)

(b) Explain Turbo coding and decoding scheme for error detection and correction. (7)

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