Exam Date & Time: 07-Dec-2023 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

VII SEMESTER B.TECH END SEMESTER EXAMINATIONS, NOV DEC 2023

Error Control Coding [ECE 4073]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

Instructions to Candidates:
Answer ALL questions Missing data may be suitably assumed

1) Determine the conjugates and minimal polynomial of α^7 over GF(2^4) with primitive polynomial $p(x)=1+x^3+x^4$ (4)

A)

B) Determine sum of α^3 and α^5 in GF(3^2) with primitive polynomial $p(x)=x^2+x+2$. (3)

C) Implement circuit to perform multiplication of two field element in GF(2^4) using $p(x)=1+x^3+x^4$. (3)

2) Construct parity equations to encode 6 bit message using the non-systematic Hamming code. Determine the code word for the message 110011. Correct the received vector (1010110101) for 1 bit error if any. (3)

A)

B) The parity check equations for a systematic (n,k) linear block code are : (3)

$V_o=u_0+u_1+u_3$; $V_1= u_0+u_2+u_3$; $V_2=u_0+u_1+u_2$; $V_3= u_1+u_2+u_3$

where u_i are message bits and V_i are parity check bits for i=1 to 3

Determine

i. How many error patterns it can correct?

ii. How many error patterns are detected?

iii. Determine the syndrome for the received vector $r(x)=1+x^3+x^6$ and detect for errors

iv. If error is detected, Estimate the error pattern & the message vector.

C) An (15,11) cyclic code is defined by polynomial $p(x)=1+x^3+x^4$. Find

i. Find the cyclic code for the message stream (10100100101)

ii. Determine the syndrome for the received code is (000010010010000). Is the received code correctable, if yes Find the corrected message code. (4)

iii. Devise a Meggitt decoder for this cyclic code and explain

3) Design the shortened decoder (27, 22) using $p(x)=1+x^2+x^5$. Show the computation of necessary design equations and implementation the decoder. (3)

A)

B) Implement the syndrome circuit for a double error correcting BCH decoder over $GF(2^4)$ using $p(x)=1+x^3+x^4$. Find the syndromes for received polynomial $r(x)=x^2+x^9$. (5)

C) Design and show the implementation of Chien's searching circuit for the triple error correcting BCH code over $GF(2^4)$ using $p(x)=1+x^3+x^4$, if the error location polynomial is $\sigma(x) = 1+\alpha^5x+ \alpha^{12}x^3$ (2)

4) Using a double error correcting RS code over $GF(2^4)$ using $p(x) = 1+x+x^4$, Determine the syndrome for $r(x)= \alpha^{12}x^3$. (2)

A)

B) Using a triple error correcting RS coding over $GF(2^4)$, $p(x) = 1+x+x^4$, the syndromes computed for a received polynomial are $\{\alpha^{12},1, \alpha^{14}, \alpha^{10}, 0, \alpha^{12}\}$. Determine the error location polynomial. (3)

C) (5)

Determine the error location numbers, if the error location polynomial is $\sigma(x) = 1+\alpha^5x+ + \alpha^6x^2+\alpha^4x^3$ for syndrome polynomial is $S=\{\alpha^5,\alpha^7,\alpha^{10},\alpha^5 , \alpha^7, \alpha^6\}$, for a triple error correcting RS coding over $GF(2^4)$, $p(x) = 1+x+x^4$,

5) The convolution Encoder is defined by generating polynomials $(1+x, 1+x^2)$. Draw the state diagram and Trellis diagram for 3 clock cycles. (3)

A)

B) For the convolution Encoder defined by $(1+x, 1+x^2)$, Determine the code word for the message (1011101) and verify the results using convolution operation. (3)

C) Decode the received bit stream {11 11 00 10 11 00 00} using the Viterbi decoding for convolutional encoder defined by $(1+x, 1+x^2)$. (4)

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