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20ECS23

Second Semester M.Tech. Degree Examination, July/August 2022
Error Control Coding

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Obtain an expression for entropy of a zero memory information source emitting independent sequence of symbols and discuss the various properties of entropy. **(10 Marks)**

b. Define Binary symmetric channel and obtain the expression for its channel capacity. **(10 Marks)**

OR

2 a. Define Mutual information. Derive and explain the properties of mutual information. **(10 Marks)**

b. Define a field and modulo 5 addition and multiplication table for GF (2). **(05 Marks)**

c. Let V be a vector space over a field F. Prove that for any c in F and any v in V, $(-c).v = c.(-v) = -(c.v)$. **(05 Marks)**

Module-2

3 a. Write a note on product coder and inter leaved codes. **(10 Marks)**

b. Form the generator matrix of the first order RM code RM (1, 3) of length 8. What is the minimum distance of the code? Determine its parity check sums and devise majority-logic ecoder for the code. Decode the received vector r = (01000101) **(10 Marks)**

OR

4 a. For a systematic (7, 4) linear block code, the parity matrix P is given by

$$P = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix}$$

i) Find all possible code vectors
ii) Draw the corresponding encoding circuit
iii) Detect and correct the following error R = [1011100]
iv) Draw the syndrome calculation circuit **(14 Marks)**

b. If C = DG is a valid vector prove that $CH^T = 0$ where H^T is transpose of parity check matrix H. **(06 Marks)**

Module-3

5 a. A (15, 5) linear cyclic code has a generator polynomial $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$.

i) Draw the block diagram of an encoder and syndrome calculator for this code
ii) Find the code polynomial for the message polynomial $D(x) = 1 + x^2 + x^4$ in systematic form
iii) Is $v(x) = 1 + x^4 + x^6 + x^8 + x^{14}$ a code polynomial? **(10 Marks)**

b. A linear Hamming code is described by a generator polynomial $g(D) = 1 + D + D^3$.

i) Determine the generator matrix G and parity check matrix
ii) Design an encoder circuit. **(10 Marks)**

OR

6 a. With a block diagram, explain decoding circuit for (31, 26) cyclic hamming code generated by $g(x) = 1 + x^2 + x^5$. If the above hamming code is shortened by three digit. Draw and explain the decoding circuit for resultant (28, 23) shortened cyclic code. **(10 Marks)**

b. With a block diagram, explain the decoding operation of error trapping decodes for a (15, 7) cyclic code generated by $g(x) = 1 + x^4 + x^6 + x^7 + x^8$. **(10 Marks)**

Module-4

7 a. Give the circuit for Galois field (2^4) adder and multiplier for multiplying GF(2^4) by α^3 and explain their operation. What is requirement of these circuits? **(10 Marks)**

b. Give the important parameter and features of RS Code. Give the encoding circuit for r-ary RS code and explain the symbol used in the circuit. **(10 Marks)**

OR

8 a. Example with suitable diagram type – 1 one step majority logic decoder error correction procedure. **(10 Marks)**

b. Determine the parameter of a q-ary RS Code over hF (16) for $d_{min} = 9$. Also find the total number of code-words in the code and also the nearest neighbour for any codeword at a distance of $d_{min} = 9$. **(10 Marks)**

Module-5

9 a. Consider the (3, 1, 2) convolution code with $g^{(1)} = (110)$, $g^{(2)} = (101)$ and $g^{(3)} = (111)$

i) Draw the encoder block diagram

ii) Find the generator matrix

iii) Find the codeword corresponding to the information sequence (11101) using time domain and transform domain approach. **(10 Marks)**

b. Explain the steps involved in viterbi algorithm with an example. **(10 Marks)**

OR

10 a. Consider the convolution encoder with $g(x) = (1 + x, 1 + x^2, 1 + x + x^2)$. If the received sequence v = [110, 110, 110, 111, 010, 101, 101]. Using Viterbi algorithms find the transmitted sequence. Assume that the codeword is transmitted over BSC channel. **(10 Marks)**

b. For a rate ½ convolution encoder with a transfer function $G(x) = [1 + x^2 + x^3, 1 + x + x^2 + x^3]$. Draw the encoder and state diagram, hence evaluate the code the codeword produced by the I/P sequence 10111. **(10 Marks)**

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