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18ECS23

## Second Semester M.Tech. Degree Examination, June/July 2019 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. Define mutual information. Derive and explain the properties of mutual information. (10 Marks)
- b. A discrete memory less source has alphabet of five symbols with their probabilities as given below :

Symbol	$S_0$	$S_1$	$S_2$	$S_3$	$S_4$
Probabilities	0.4	0.2	0.2	0.1	0.1

Compute Huffman code by placing composite symbol as high as possible and by placing composite symbol as low as possible. Also find the :

- i) The average code word length
- ii) The variance of the average code word for both of the cases. (10 Marks)

**OR**

- 2 a. For a set integers  $G = \{0, 1, 2, \dots, m-1\}$  where  $m$  is any +ve integer, show that  $(i \boxplus j) \boxplus k = i \boxplus (j \boxplus k)$  where  $\boxplus$  denotes module in addition. (08 Marks)
- b. Explain the construction of Galois field  $G^F(2^m)$  a field  $F$ . (08 Marks)
- c. Let  $V$  be a vector space over a field  $F$ .  
Prove that for any  $C$  in  $F$  and any  $V$  in  $V$   $(-C) \cdot (V) = C \cdot (-V) = -(C \cdot V)$ . (04 Marks)

### Module-2

- 3 a. The syndrome of a (7, 4) linear code is given by :
- $S_0 = r_0 + r_3 + r_5 + r_6$
- $S_1 = r_1 + r_3 + r_4 + r_5$
- $S_2 = r_2 + r_4 + r_5 + r_6$
- Find the following :
- i) Find the generator matrix draw the encoder circuit
- ii) Draw syndrome circuit
- iii) Find all possible code vectors
- iv) How many errors can it detect and correct?
- v) Detect and correct errors if  $r = 1001010$ . (14 Marks)
- b. If  $C = DG$  is a valid code vector prove that  $CH^T = 0$  where  $H^T$  is transpose of parity check matrix  $H$ . (06 Marks)

**OR**

- 4 a. Write a note on product codes and interleaved codes. (10 Marks)
- b. Form the generator matrix of a second order reed Muller code RM ( $r = 2, m = 4$ ) of length 16. What is the minimum distance of the code? (10 Marks)

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-3

- 5 a. A (15, 5) binary cyclic code has a generator polynomial  $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$ .
- Draw the encoder block diagram
  - Find the code polynomial for message polynomial  $d(x) = 1 + x^2 + x^4$  in systematic form.
  - Is  $v(x) = 1 + x^4 + x^6 + x^8 + x^{14}$  a code polynomial? If not find the syndrome of  $v(x)$ . (10 Marks)
- b. With a block diagram, explain the decoding operation of error trapping decoder for a (15, 7) cyclic code generated by  $g(x) = 1 + x^4 + x^6 + x^7 + x^8$ . (10 Marks)

OR

- 6 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 digits. Draw and explain the decoding circuit for resultant (28, 23) shortened cyclic code. (20 Marks)

Module-4

- 7 a. Give the circuit for Galois field  $GF(2^4)$  adder and multiplier (for multiplying  $GF(2^4)$  by  $\alpha^3$ ) and explain their operation. What is requirement of these circuits? (10 Marks)
- b. Give the important parameters and features of RS code. Give the encoding circuit for q-ray R - S code and explain the symbols used in the circuit. (10 Marks)

OR

- 8 a. Example with suitable diagram type-I one step majority logic decoder error correction procedure. (10 Marks)
- b. Draw and explain type-2, two step majority logic  $g(x) = 1 + x + x^3$ . (10 Marks)

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

(10 Marks)

Module-5

- 9 a. For a rate  $\frac{1}{2}$  convolutional encoder with a transfer function :  
 $G(x) = [1 + x^2 + x^3, 1 + x + x^2 + x^3]$ , draw the encoder circuit and state diagram, hence evaluate the codeword produced by the input sequence 1 0 1 1 1. (10 Marks)
- b. With a flow chart explain ZJ or stack algorithm. (10 Marks)

OR

- 10 a. Explain the steps involved in viterbi algorithm. (06 Marks)
- b. Consider the convolutional 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 algorithm find the transmitted bit sequence. Assume that the codeword is transmitted over BSC channel. (14 Marks)

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