

D 51554

(Pages 3)

Name.....

Reg. No.....



**FIFTH SEMESTER B.TECH. (ENGINEERING) DEGREE  
EXAMINATION, DECEMBER 2008**

**IT 2K 503—INFORMATION THEORY AND CODING**

Time : Three Hours

Maximum : 100 Marks

*Answer all questions.*

- I. (a) A discrete source emits one of 5 symbols once every millisecond with probabilities  $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}$  and  $\frac{1}{16}$  respectively. Determine the source entropy and information rate.

- (b) For the given channel matrix, compute the mutual information  $I(X, Y)$  with uniform input distribution.

$$\begin{bmatrix} \frac{2}{3} & \frac{1}{3} & 0 \\ 0 & \frac{1}{6} & \frac{5}{6} \end{bmatrix}$$

- (c) Explain error detection and correction capabilities of Hamming codes.  
(d) What are the advantages and disadvantages of cyclic codes ?  
(e) Define minimal polynomial,  $\phi(x)$  of a field element and show that it is irreducible.  
(f) Construct the vector space of all 3-tuples over a finite field with elements  $\{0, 1\}$  and form a 2-dimensional subspace and its dual space.  
(g) Define transfer function matrix and explain in convolutional code.  
(h) What is meant by catastrophic code ? Explain.

(8 × 5 = 40 marks)

- II. (a) (i) Define discrete entropy,  $H(x)$ , of a source with symbols  $\{x_1, x_2, \dots, x_M\}$ . Show that  $H(X)$  is maximum when all the source symbols are equiprobable.

(11 marks)

- (ii) What is meant by lossless and noiseless channel ? What is channel capacity of them ?

(4 marks)

*Or*

**Turn over**

- (b) Consider a source with symbols  $\{x_1, x_2, x_3, x_4\}$  and its corresponding probabilities  $\{1/2, 1/4, 1/8, 1/8\}$ . Construct extension of source with 2 symbols and design a code for the new symbols using (i) Shannon-Fano coding procedure and (ii) Huffman coding procedure. Compare their coding efficiencies. (7 + 8 = 15 marks)

III. (a) The generator matrix for a (6, 3) linear block code is given by :

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

- (i) Obtain all the code words and parity check matrix H. (4 marks)  
 (ii) What is the minimum distance of the code ? (1 mark)  
 (iii) Construct standard array for this code and hence determine syndromes for the coset leaders. (10 marks)

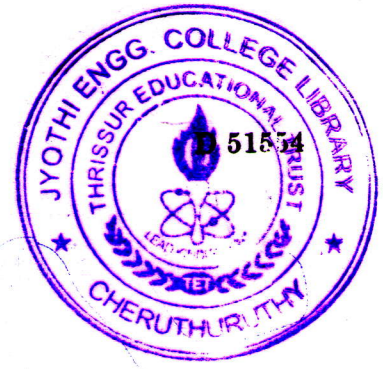
Or

- (b) (i) Let  $g(x)$  be the generator polynomial of an  $(n, k)$  cyclic code. Show that a binary polynomial of degree  $n - 1$  or less is a code polynomial if and only if it is multiple of  $g(x)$ . (8 marks)  
 (ii) Draw the syndrome calculation circuit for a (7, 4) cyclic code with generator polynomial  $g(x) = 1 + x + x^3$ . Evaluate the syndrome for the received sequence 1001101 using circuit. (7 marks)

IV. (a) Construct a table for the finite field  $GF(2^4)$  based on the primitive polynomial  $p(x) = 1 + x + x^4$ . Find the minimal polynomial of the element  $\alpha^3$ . Assume  $\alpha$  be the primitive element. (15 marks)

Or

- (b) (i) Let ' $\alpha$ ' be a primitive element of the Galois field  $GF(2^3)$  such that  $1 + \alpha + \alpha^3 = 0$ . Find the generator polynomial and generator matrix of the single-error correcting BCH code. (10 marks)  
 (ii) What is meant by error location polynomial ? Explain. (5 marks)



V. (a) The transfer function of the (3, 2, 1) convolutional code is given by :

$$G(D) = \begin{bmatrix} 1+D & D & 1+D \\ D & 1 & 1 \end{bmatrix}$$

- (i) Construct encoder block diagram.
- (ii) Find generator matrix.
- (iii) Find the code polynomial for the input polynomials  $U^{(1)}(D) = 1 + D^2$  and  $U^{(2)}(D) = 1 + D$ .
- (iv) Construct state diagram.

(3 + 3 + 3 + 6 = 15 marks)

Or

(b) (i) Explain viterbi algorithm for decoding of convolutional code. (6 marks)

- (ii) Draw the trellis diagram of a rate  $-\frac{1}{2}$ , constraint length – 3 convolutional code with generator sequences :  $g^{(1)} = (1 \ 1 \ 1)$  and  $g^{(2)} = (1 \ 0 \ 1)$ , viterbi algorithm, compute the decoded sequence for the received sequence.

{11, 10, 00, 01, 10, 01, 11}.

(9 marks)

[4 × 15 = 60 marks]