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(2 Pages)

Name.....

Reg. No.....

**FIFTH SEMESTER B.Tech. (ENGINEERING) DEGREE EXAMINATION
DECEMBER 2004**

(New Scheme)

IT 2K 503—INFORMATION THEORY AND CODING

Time : Three Hours

Maximum : 100 Marks

Answer all questions.

- I. (a) Define discrete entropy and calculate entropy for the source having probabilities, $\left\{ \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8} \right\}$.
- (b) Derive channel capacity formula for symmetric channel.
- (c) What is linear block code ? Explain.
- (d) Explain about error detecting capabilities of cyclic code.
- (e) Construct elements of Galois field $GF(2^3)$, using irreducible polynomial $P(X) = X^3 + X^2 + 1$.
- (f) State axioms of vector space.
- (g) Explain about constraint length and free distance with respect to convolution code.
- (h) Explain about sequential decoding.

(8 × 5 = 40 marks)

- II. (a) (i) Define joint entropy, $H(X, Y)$ and conditional entropies $H(X/Y)$ and $H(Y/X)$ of two random variables. Show that :
- (i) $H(X, Y) \leq H(X) + H(Y)$.
- (ii) $H(X) \geq H(X/Y)$.
- (iii) $H(Y) \geq H(Y/X)$.

(8 marks)

- (ii) State and prove source coding theorem.

(7 marks)

Or

- (b) (i) Construct binary code for the following source probabilities using Huffman coding procedure and calculate coding efficiency.

0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05, 0.02

(8 marks)

- (ii) Find the channel capacity of the channel with channel matrix :

$$\begin{bmatrix} 0.1 & 0.8 & 0.1 \\ 0.8 & 0.1 & 0.1 \\ 0.1 & 0.1 & 0.8 \end{bmatrix}$$

(7 marks)

Turn over

III. (a) The generator matrix of 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 of the code.
- (ii) Find minimum distance of the code.
- (iii) Construct encoder and syndrome calculation circuit.
- (iv) Find parity check matrix.

(3 + 2 + 8 + 2 = 15 marks)

Or

(b) The generator polynomial of a (7, 4) cyclic code is given by $g(X) = X^3 + X + 1$.

- (i) Obtain generator matrix in systematic form.
- (ii) Construct encoder and syndrome computation circuits for this code.

(7 + 8 = 15 marks)

IV. (a) (i) Write the addition and multiplication tables for the field of 4-elements {0, 1, 2, 3}. Using the table, solve the equations :

$$2X + Y = 3$$

$$X + 2Y = 3.$$

(9 marks)

(ii) Explain about linearly independent set of vectors in a vector space.

(6 marks)

Or

(b) (i) Define BCH code and explain how do you determine generator polynomial of the t -error correcting BCH code.

(8 marks)

(ii) Write short note on Reed Solomon code.

(7 marks)

V. (a) Explain :

- (i) Time-domain approach.
- (ii) Transform-domain approach of a convolution code with an example.

(15 marks)

Or

(b) A convolution encoder has a single shift register with two stages, (that is constraint length is 3), three modulo-2 adders, and an output multiplexer. The generator sequence of the encoder are given by :

$$g^{(1)} = (1, 0, 1)$$

$$g^{(2)} = (1, 1, 0)$$

$$g^{(3)} = (1, 1, 1)$$

- (i) Draw the block diagram of encoder.
- (ii) Find the code word corresponding to the message 10111.
- (iii) Construct state diagram and trellis diagram, assuming message sequence length of 5.

(15 marks)

[4 × 15 = 60 marks]