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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Fifth Semester, B.E. - Electronics and Communication Engineering
Semester End Examination; Dec. - 2015
Information Theory and Coding

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Assume missing data, if any, suitably.

UNIT - I

1 a. Define:

i) Self information ii) Entropy 4

(iii) Rate of information iv) Mutual Information

b. Derive an expression for average information content of long independent messages. 6

c. State and prove source coding theorem. 10

2 a. State and prove Kraft Inequality. 6

b. Apply Huffman encoding procedure for the following set of messages and find efficiency. Apply the same to the second order extension and find how much efficiency is been improved, 10

$\{X_1, \ X_2, \ X_3\} = \{0.7, \ 0.15, \ 0.15\}$

c. A code is composed of dots and dashes. Assuming that a dash is 3 times as long as a dot and has one third the probability of occurrence of dot. Calculate: 4

(i) The information in a dot and dash (ii) The entropy of dot-dash code

UNIT - II

3 a. State Shannon's Heartley law and write its implications. 4

b. State the properties of mutual information prove that mutual information is symmetric and nonnegative. 8

c. For a given joint probability matrix compute, 8

$H(X), H(Y), \ H(X,Y), \ H(X/Y), \ H(Y/X) \ \& \ I(X,Y)$

$$P(X,Y) = \begin{bmatrix} 0.05 & 0 & 0.2 & 0.05 \\ 0 & 0.1 & 0.1 & 0 \\ 0 & 0 & 0.2 & 0.1 \\ 0.05 & 0.05 & 0 & 0.1 \end{bmatrix}$$

4 a. Explain with neat block diagram, the digital communication system indicating the various types of communication channels. Also define the various probabilities. 8

Contd……2

b. Two noisy channels are cascaded whose channel matrices are given below. Given $P(X_1) = P(X_2) = \frac{1}{2}$ Find $I(X,Y)$, $I(X,Z)$ & show that $I(X,Y) > I(X,Z)$ 12

$$P\left(Y/X\right) = \begin{bmatrix} 1/6 & 1/6 & 2/3 \\ 1/2 & 1/4 & 1/4 \end{bmatrix} \quad P\left(Z/Y\right) = \begin{bmatrix} 1/2 & 1/2 & 0 \\ 1/3 & 2/3 & 0 \\ 0 & 1/3 & 2/3 \end{bmatrix}$$

UNIT - III

5 a. What are the different methods of controlling Errors? Explain. 6

b. For a systematic (7, 4) linear block code the party matrix is given below:

(i) Find all possible code vectors.

(ii) A single error has occurred in each of these received vectors, correct them. $Y_A = 0111110$, $Y_B = 1011100$ and $Y_C = 1010000$ 6

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

c. Define:

(i) Hamming weight (ii) Hamming distance 8

(iii) Code rate (iv) Block code.

6. a. Parity check matrix of (7, 4) Hamming code are given by $C_5 = d_1 \oplus d_3 \oplus d_4$, $C_6 = d_1 \oplus d_2 \oplus d_3$, $C_7 = d_2 \oplus d_3 \oplus d_4$ where $d_1,\ d_2,\ d_3,\ d_4$ are message bits:

(i) Find generator and parity check matrix

(ii) Prove that $GH^T = 0$

(iii) The (n,k) linear block code so obtained has a dual code, This dual code is a $(n, n-k_1)$ code having a generators matrix H. Determine the eight code vectors of the dual code for the (7,4) Hamming code described above. 12

(iv) Find the minimum distance of the dual code determine in part (iii).

b. Explain the matrix representation of linear block codes. 6

c. Define:

(i) Systematic linear blocks code 2

(ii) Burst error.

UNIT - IV

7 a. Explain the matrix description of cyclic codes. 10

b. What is a binary cyclic code? Find the code word for messages 1001 and 1011. 10

8 a. Explain the following codes:

(i) RS codes (ii) Golay codes 10

(iii) Shortened cyclic codes (iv) Burst error correction codes.

b. The generation polynomial for (15, 7) cyclic code is $g(x) = 1 + x^4 + x^6 + x^7 + x^8$,

(i) Find the code vector in systematic form for the message $D(x) = x^2 + x^3 + x^4$ 10

(ii) Assume that first and last bit of the code vector $V(x)$ for $D(x) = x^2 + x^3 + x^4$ suffer transmission errors. Find the syndrome of $V(x)$.

UNIT - V

9 a. For the convolution encoder shown in Fig. Q9(a) determine the following :

(i) Dimensions of the code (ii) Code rate (iii) Generator sequence

(iv) Output sequence for message sequence $m = \{1\ 0\ 0\ 1\ 1\}$ using time domain and transform domain approach. 10

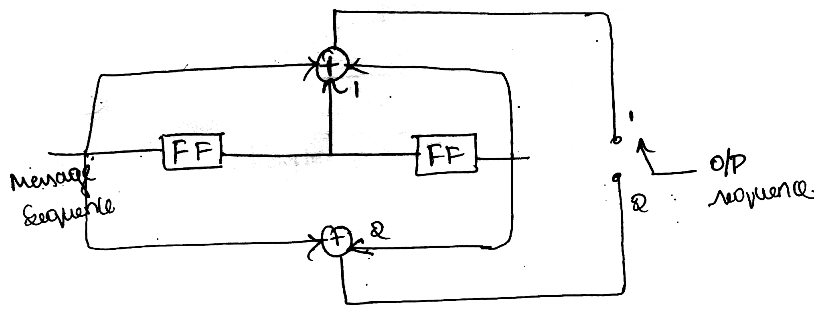

Fig. Q9 (a)

b. Consider the $(3,1,2)$ convolutional code with $g^{(1)} = (110)$, $g^{(2)} = (101)$, $g(3) = (111)$,

i) Draw the encoder block diagram

ii) Find the generator matrix 10

iii) Find the code word corresponding to the information sequence (11101) using time and transform domain approach.

10 a. Explain the concept of coded modulation. 10

b. Illustrate the Underboeck's TCM design rules. 10

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