Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(ECE)/SEM-7/EC-703/2011-12

2011

CODING & INFORMATION THEORY

Time Allotted : 3 Hours Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) A (7, 4) linear block code has a code rate of

a) 7 b) 4

c) 1·75 d) 0·571.

ii) Entropy represents

a) amount of information

b) rate of information

c) measure of uncertainty

d) probability of message.

iii) The channel capacity is a measure of

a) entropy rate

b) maximum rate of information a channel can handle

c) information contents of messages transmitted in a channel

d) none of these.

iv) The Hamming distance between V = 1100001011 and W = 1001101001 is

a) 1 b) 5

c) 3 d) 4.

v) An encoder for a (4, 3, 5) convolution code has a memory order of

a) 4 b) 2

c) 3 d) 5.

vi) Which of the following expressions is incorrect ?

a) $H\ (\ y/x\ ) = H\ (\ x,\ y\ ) - H\ (\ x\ )$

b) $I\ (\ x,\ y\ ) = H\ (\ x\ ) - H\ (\ y/x\ )$

c) $H\ (\ x/y\ ) = H\ (\ x,\ y\ ) + H\ (\ y\ )$

d) $I\ (\ x,\ y\ ) = H\ (\ y\ ) - H\ (\ y/x\ )$.

vii) A polynomial is called monic if

a) odd terms are unity

b) even terms are unity

c) leading coefficient is unity

d) leading coefficient is zero.

viii) Which of the following techniques is used for Viterbi algorithm for decoding ?

a) Code tree b) Trellis

c) State diagram d) Parity generator.

ix) The generator polynomial of a cyclic code is a factor of

a) $x^n + 1$ b) $x^{n+1} + 1$

c) $x^{n+2} + 1$ d) none of these.

x) Consider the parity check matrix $H = \begin{vmatrix} 100 \\ 010 \\ 001 \\ 110 \\ 011 \\ 101 \end{vmatrix}$ and the received vector r = (001110). Then the syndrome is given by

a) (110) b) (100)

c) (111) d) (101).

xi) For a (7, 4) cyclic code generated by $g(X) = 1 + X + X^3$ the syndrome for the error pattern $e(X) = X^3$ is

a) 101 b) 111

c) 110 d) 011.

xii) The number of undetectable errors for a (n, k) linear code is

a) 2^{n-k} b) 2^n

c) $2^n - 2^k$ d) 2^k .

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. a) Differentiate between block cipher and stream cipher. 2

   b) What do you mean by symmetric key and asymmetric key cryptography ? What is 'Man-in-the middle' attack ?

   2 + 1

3. A (8, 4) cyclic code is generated by $g(X) = 1 + X + X^4$. Find the generator and parity-check matrix in systematic form. 3 + 2

4. a) What is the systematic structure of a code word ? 1

   b) What is syndrome and what is its significance ? Draw the syndrome circuit for a (7, 4) linear block code with parity-check matrix $H = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \end{bmatrix}$. 2 + 2

5. For a (2, 1, 3) convolutional encoder the generator sequences are g^{0} = (1000) and $g^{(1)}$ = (1101).

6. Determine the generator polynomial of a double error correcting BCH code of block length, n = 15.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. Consider a systematic (8, 4) code with parity check equations

$V_0 = U_0 + U_1 + U_2$

$V_1 = U_1 + U_2 + U_3$

$V_2 = U_0 + U_1 + U_3$

$V_3 = U_0 + U_2 + U_3$

where U_0 , U_1 , U_2 and U_3 are message, V_0 , V_1 , V_2 and V_3 are parity check digit

i) Find the generator matrix and the parity check matrix for this code.

ii) Find the minimum weight for this code.

iii) Find the error detecting and the error correcting capability of this code.

iv) Show through an example that the code can detect three errors in code word. 6 + 4 + 4 + 1

8. a) State and prove the Shannon-Hartley law of channel capacity. 1 + 5

b) A Gaussian channel has a 1 MHz bandwidth. If the signal power-to-noise power spectral density **Error!**

c) Show that $H (X, Y) = H (X/Y) + H (Y)$. 4

9. a) Show that C = { 0000, 1100, 0011, 1111 } is a linear code. What is its minimum distance ? 4 + 1

b) A (7, 3) linear code has the following generator matrix :

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

Determine a systematic form of G. Hence find the parity-check matrix H for the code. 3 + 2

c) Design the encoder circuit for the above code. 5

10. a) Write down the advantages of Huffman coding over Shannon-Fano coding.

b) A discrete memoryless source has seven symbols x_1, x_2, x_3, x_4, x_5, x_6 and x_7 with probabilities of occurrence $P(x_1) = 0{\cdot}05$, $P(x_2) = 0{\cdot}15$, $P(x_3) = 0{\cdot}2$, $P(x_4) = 0{\cdot}05$, $P(x_5) = 0{\cdot}15$, $P(x_6) = 0{\cdot}3$ and $P(x_7) = 0{\cdot}1$.

Construct the Huffman code and determine

i) Entropy

ii) Average code length

iii) Code efficiency. 3 + 5 + 3 + 3 + 1

11. a) What are the functions of P-box and S-box in case of DES algorithm ?

b) Explain the Diffy-Hellman key exchange algorithm.

c) What do you mean by Quantum Cryptography ? 4 + 9 + 2

12. Write short notes on any *three* of the following : 3 × 5

a) Shannon-Fano algorithm

b) Advanced version of DES

c) RSA algorithm

d) Hamming coding

e) Viterbi algorithm.