Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/IT/NEW/SEM-6/IT-604A/2013

2013

INFORMATION THEORY & CODING

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) The entropy of an information source is maximum when the symbol occurrences are

a) equiprobable

b) different probable

c) both (a) and (b)

d) none of these.

ii) Measure of information $I(m_k)$ of a message m_k with probability p_k is given by

a) $\log_b\left(\frac{1}{p_k}\right)$

b) $\log_b\left(\frac{1}{1-p_k}\right)$

c) $\log_b(1-p_k)$

d) $\log_b(p_k)$.

iii) Which of the following expressions is incorrect ?

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

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

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

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

iv) Entropy represents

a) amount of information

b) rate of information

c) measure of uncertainty

d) probability of message.

v) Code efficiency will be maximum when average code length (L) & entropy [H (x)] are related as

a) $L = H(x)$

b) $L > H(x)$

c) $L < H(x)$

d) none of these.

vi) For GF (2^3), the elements in the set are

a) { 1, 2, 3, 4, 5, 6, 7 }

b) { 0, 1, 2, 3, 4, 5, 6 }

c) { 0, 1, 2, 3 }

d) { 0, 1, 2, 3, 4, 5, 6, 7 }.

vii) 100110 $\oplus$ 011011, when $\oplus$ represents modulo-2 addition of binary numbers, yields

a) 100111

b) 111101

c) 000001

d) 011010.

viii) A polynomial is called monic if

a) odd terms are unity

b) even terms are unity

c) leading co-efficienct is unity

d) leading co-efficient is zero.

ix) For the code C = (0000, 0101, 1010, 1111), the minimum distance is

a) 1

b) 2

c) 3

d) 4.

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

a) 7

b) 4

c) 1.75

d) 0.571.

xi) The Hamming distance between A = 1100001011 and B = 1001101001 is

a) 1

b) 3

c) 4

d) 5.

xii) If a telephone channel has a bandwidth of 3000 Hz and SNR = 20 dB, the channel capacity is

a) 19.97 kbps

b) 1.19 kbps

c) 2.19 kbps

d) 1.19 bps.

GROUP – B

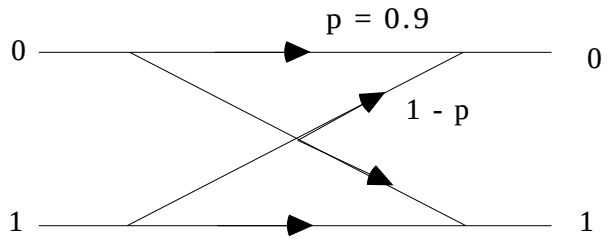
(Short Answer Type Questions)

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

2. a) Define Entropy of a source.

   b) A discrete memoryless source has five symbols x_1, x_2, x_3, x_4 and x_5 with probabilities of occurrence $P(x_1) = 0.4$, $P(x_2) = 0.19$, $P(x_3) = 0.16$, $P(x_4) = 0.15$, $P(x_5) = 0.1$. Construct Huffman quaternary code and determine the code efficiency of the source. 2 + 3

3. For a BSC shown below find the channel capacity. Derive the formula that you have used.



4. What are the error detection and correction capabilities of block code ?

5. Write down the steps necessary to encode a cyclic code in symmetric form. Consider the (7, 4) cyclic code generated by $g(X) = 1 + X + X^3$. If $u(X) = 1 + X$ is the message to be encoded, find the code polynomial and the corresponding code vector.

6. Explain the measure of information with reference to probability of occurrence of an event.

GROUP – C

(Long Answer Type Questions)

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

7. a) State the channel capacity of a white, band-limited Gaussian channel. Derive an expression of noisy channel when bandwidth tends to be very long.

   b) Explain the terms Self information, Channel capacity, Mutual information and Conditional entropy. 7 + 8

8. A code is composed of dots and dashes. Assume that the dash is 3 times as long as the dot and has one-third the probability of occurrence. Calculate :

   i) the information in a dot and that in a dash.

   ii) the average information in the dot-dash code.

   iii) the average rate of information if a dot lasts for 10 ms and this same time interval is allowed between the symbols. 5 + 5 + 5

9. a) Draw the syndrome circuit for the (7, 4) cyclic code generated by $g(X) = 1 + X + X^3$. Suppose that the received vector is r = (0010110). Find the syndrome of r. What are the contents of the resistor after the 7th shift ?

   b) What is the principle of operation of Meggitt Decoder. Let the transmitted vector be 1001011 and the received vector be 1011011. Show the error correcting procedure using Meggitt Decoder. 7 + 8

10. a) Find an expression for the probability of decoding error in block code with transition probability p. Hence calculate its value for a (6, 3) code. The weight distribution of its coset leaders is $\alpha 0 = 1$, $\alpha 1 = 6$, $\alpha 2 = 3$, $\alpha 3 = 5$, $\alpha 4 = \alpha 5$, $\alpha 5 = \alpha 6 = 0$.

b) Write short notes on the following

i) Binary Symmetric Channel

ii) Standard Array. 7 + (4 + 4)

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

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

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

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

c) Design the encoder circuit for the above code.

(4 + 1) + (3 + 2) + 5

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

a) Shannon's (three) theorems in communication

b) Shannon-Fano Algorithm

c) Hamming Code

d) Huffman Code

e) Golay Code.