2014

Information Theory and Coding

Time Alloted : 3 Hours *Full Marks : 70*

The figure 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: 10x1=10

i) The condition of a dual code in case of linear block code is

a) $GH^T=0$
b) $(HG)^T=0$
c) $H^TG^T=0$
d) $GH^T=1$

ii) The binary Hamming Codes have the property that

a) $(n, k)=(2^m+1, 2^m-1-m)$
b) $(n, k)=(2^m-1, 2^m-1+m)$
c) $(n, k)=(2^m-1, 2^m-1-m)$
d) $(n, k)=(2^m-1, 2^{m-t}-m)$

iii) If m=4 then what will be the length of the BCH Code?

a) 16
b) 17
c) 15
d) none of these.

iv) A (7,4) Linear Block Code with minimum distance guarantees error detection of

a) ≤ 4 bits
b) ≤ 2 bits
c) ≤ 3 bits
d) None of these

v) 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}

vi) A code with minimum distance d_{min} =5. How many errors it can correct'

a) 3
b) 4
c) 2
d) 1

vii) The Hamming distance between v = 1100001011 and w = 1001101001 is

a) 1
b) 5
c) 3

d) 4

viii) Cyclic redundancy check is a type of

a) Convolution code
b) cyclic code
c) Parity check code
d) none of these.

ix) Consider the parity check matrix H= $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 0 & 1 \end{pmatrix}$ and the received vector r= (001110). Then the syndrome is given by

a) (110)
b) (100)
c) (111)
d) (101)

x) A (8,4) linear code has a code rate of

a) 8
b) 4
c) 0.5
d) 2

xi) For a (7, 4) cyclic code generated by g(x) =1+ x+x3 syndrome for the error pattern e(x)=x^3 is

a) 101
b) 011

c) 111
d) 110.

xii) Entropy means

a) amount of information
b) rate of information
c) measure of uncertainty
d) probability of message

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

a) equi-probable
b) different probability
c) both (a) & (b)
d) none of these

xiv) Measure of information of a message mi< with probability pu is given by

a) $\log_b (1/p_k)$
b) $\log_b (p_k)$
c) $\log_b (1-p_k)$
d) $\log_b (1/1-p_k)$

xv) A source delivers symbols m_1, m_2, m_3 and m_4 with probabilities 1/2, 1/4, 1/8 and 1/8 respectively. The entropy of the system is

a) 1.75 bits/sec
b) 1.75 bits/symbol
c) 1.75 symbols
d) 1.75 symbol/bit

GROUP - B
(Short Answer Type Questions)

Answer any *three* of the following. 3x5=15

2. 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

3. a) What is systematic structure of a code word?

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

4. Determine the generator polynomial of a double error correcting BCH code of block length, n=15 5

5. A discrete memory less source has five symbols $x_1, x_2, x_3, x_4, \text{and } x_5$ with probabilities of occurrence $P(x_1) = 0.4, P(x_2) = 0.19, P(x_3) = 0.16, P(x_4) = 0.15 \text{and} P(x_5) = 0.1$ Construct the Huffman code. 5

6. State and explain source encoding theorem. 5

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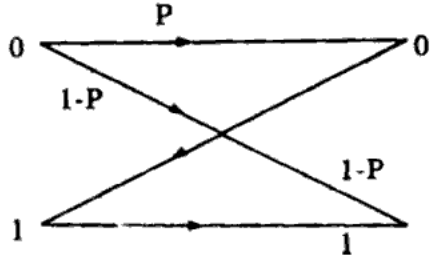
GROUP - C
(Long Answer Type Questions)

Answer any *three* of the following. 3x15=45

7. Draw the block diagram of a typical data transmission system and explain the function of each block. 5

8. For a BSC shown below find the channel capacity for P=0.9 Derive the formula that you have used.



5+10

9. The parity cheek bits of a (8, 4) block code are generated by $c_5 = d_1 \oplus d_2 \oplus d_4, c_6 = d_1 \oplus d_2 \oplus d_3, c_7 = d_1 \oplus d_3 \oplus d_4, c_8 = d_2 \oplus d_3 \oplus d_4$ 6

   a) Find the generator matrix and the parity check matrix of this code. 4

   b) Find the minimum weight of this code 4

   c) Find the error detecting and the error correcting capability of this code 4

   d) Show through an example that this code can detect three errors/code word. 1

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10. What is syndrome array? Explain how the standard array can be used to make a correct decoding?

2+3

b) Consider the (7,4) linear block code whose decoding table is given below:

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Syndrome	Coset leader
100	1000000
010	0100000
001	0010000
110	0001000
011	0000100
111	0000010
101	0000001

Show with an example that this code can correct any single error but makes a decoding error when two or more errors occur.

c) Show that if the minimum distance of a t-error correcting code is d_{min}, $then \leq (d_{min} - 1)/2$

4

11. A (15,5) linear cyclic code has a generator polynomial has $g(x) = 1 + x + x^2 + x^4 + x^5 + x^8 + x^{10}$

a) Draw the block diagram of the encoder for this code

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b) Find the code polynomial $d(x) = 1 + x^2 + x^4$ for the message polynomial (in a systematic form)

5

c) Is $v(x) = 1 + x^4 + x^6 + x^8 + x^{14}$ a code polynomial? If not , fi the syndrome of $v(x)$

d) A (7,4) linear cyclic code has a generator polynom $g(x) = 1 + x^2 + x^3$. Draw the syndrome circuit and find out t syndrome showing all the contents of the resister in all t required shifts for r=0010110

12. Write short notes on (any three):

a. Error control strategies

b. Shannon-Fano algorithm

c. Hamming coding

d. Huffman code

e. Golay codes