



Name :

Roll No. :

Invigilator's Signature :

**CS/B.Tech(IT)/SEM-7/IT-703E/2009-10
2009**

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 of the following : $10 \times 1 = 10$
 - i) $(P + 1)$ is not a generator polynomial for a $(7, 4)$ cyclic code, because
 - a) it is not a factor of $(P^7 + 1)$
 - b) its degree is > 7
 - c) its degree is < 7
 - d) none of these.
 - ii) If X is the message code vector and H is the parity check matrix then value of XH^T is always
 - a) 1
 - b) 0
 - c) depending upon H
 - d) none of these.



- iii) The code $C = \{ 0000, 0101, 1010, 1111 \}$ is a
- a) linear code b) cyclic code
- c) linear cyclic code d) none of these.
- iv) For a $(2, 1, 2)$ convolution encoder, impulse response is 1101. The output code word for data 101 is
- a) 01110111 b) 11011101
- c) 11001110 d) 01010101.
- v) If $I(x_1)$ and $I(x_2)$ are the information carried by two symbols x_1 and x_2 respectively then information carried compositely due to x_1 and x_2 is
- a) $I(x_1, x_2) = I(x_1) + I(x_2)$
- b) $I(x_1, x_2) = I(x_1) - I(x_2)$
- c) $I(x_1, x_2) = I(x_1) * I(x_2)$
- d) none of these.
- vi) Using Error Control coding distance required to detect up to s errors per word if
- a) $d_{min} \leq s + 1$ b) $d_{min} \geq s + 1$
- c) $d_{min} \leq 2s + 1$ d) $d_{min} \geq 2s + 1$.



vii) The information content of a symbol x_i is denoted by $I(x_i) = -\log_b P(x_i)$. If $b = e$ then this information is

- a) Hartley
- b) Decit
- c) Nat
- d) bit.

viii) Weight of the code 011100110 is

- a) 5
- b) 4
- c) 1
- d) 3.

ix) Goley code is

- a) (27, 13) code
- b) (25, 13) code
- c) (27, 12) code
- d) (25, 12) code.

x) A DMS with two symbols x_1 , x_2 and $P(x_1) = 0.1$ and $P(x_2) = 0.9$ are coded as 0 and 1 respectively.

Thus the entropy is

- a) 0.469 b/symbol
- b) 0.569 b/symbol
- c) 0.369 b/symbol
- d) 0.669 b/symbol.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. Consider a binary memoryless source X with two symbols x_1 and x_2 . Show that entropy will be maximum when both x_1 and x_2 are equiprobable.
3. The Generator Matrix for a (6, 3) linear block code is shown below. Obtain the code word for message vector 101.

Error!)

4. Obtain the systematic form of generator matrix corresponding to $G(P) = P^3 + P + 1$. Also find the code vectors for (7, 4) cyclic codes for the data word 1011.
5. Using the Polynomial representation process find out the output code word for the given encoder, when the input data is 11011.
6. What is BCH code ? How will you decode BCH code ? Explain with example.



GROUP – C
(Long Answer Type Questions)
Answer any *three* of the following.

3 × 15 = 45

7. a) What do you mean by Convolutional coding ? 2
- b) Consider the following $\frac{1}{2}$ rate coder and draw the state diagram. 3
- c) Draw the tree diagram for this encoder. 3
- d) From this tree diagram find out the output code words for the data bit 101. 2
- e) Draw the Trellis diagram for that encoder. 5
8. a) What is systematic code ? When is it Linear ? Give examples. 3
- b) The Parity check matrix of a (7, 4) Hamming code is given below. find out generator matrix 3

$$H(x) = \begin{pmatrix} 1 & 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 & 1 \end{pmatrix}$$



- c) Find out the syndrome if single errors occurred at third and second bit. 4
- d) If the received code word is 1001101 then find out the correct code word. 5
9. a) Show that the non-zero code polynomial of minimum degree in a cyclic code C is unique. 2
- b) For a $(7, 4)$ cyclic code the generator polynomial is given by $P^3 + P^2 + 1$. Obtain the code vectors in systematic and non-systematic form for the message 0101. 3 + 3
- c) Obtain the generator matrix both in systematic and non-systematic form for the above same polynomials. Also find out the code vectors for message 1001. 2 + 3 + 2
10. For a $(6, 3)$ systematic linear block code, the three parity-check bits c_4, c_5, c_6 are formed from the following equations for $d = 001$ and $d = 101$:
- $$c_4 = d_1 \approx d_3$$
- $$c_5 = d_1 \approx d_2 \approx d_3$$
- $$c_6 = d_1 \approx d_2$$
- a) Write down the generator matrix for each data. 4
- b) Construct all possible code words for both $d = 001$ and $d = 101$. 4
- c) Suppose that the received word is 010111. Decode the correct code word by finding the location of single error for both data. 7



11. a) What do you mean by entropy of a source ? 1
- b) An analog signal is band limited to f_m Hz and sampled at Nyquist rate. The samples are quantized into 4 levels having probability of occurrence $P(x_1) = P(x_4) = \frac{1}{8}$ and $P(x_2) = P(x_3) = \frac{3}{8}$. Obtain the entropy and information rate of the source. 4
- c) A DMS X has six symbols of $x_1, x_2, x_3, x_4, x_5, x_6$ with $P(x_1) = 0.30, P(x_2) = 0.25, P(x_3) = 0.05, P(x_4) = 0.12, P(x_5) = 0.20$ and $P(x_6) = 0.08$. Construct a Huffman code for X . 5
- d) Find out (i) entropy, (ii) average code length, (iii) coding efficiency, (iv) redundancy, of the code in 11 (c). Also check whether it satisfies Kraft inequality or not. 5

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