

Name :

Roll No. :

Invigilator's Signature :

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

2013

INFORMATION THEORY AND 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 binary symbols 0 and 1 are transmitted with probabilities $\frac{1}{2}$ and $\frac{3}{4}$ respectively. The corresponding self information are

- a) 2 bits & 0.415 bits b) 0 & 1 bits
c) 1 & 0 bits d) 0 & 0 bits.

- ii) A source $X = \{ x_1, x_2, x_3 \}$ emits symbols with

$P = \left\{ \frac{1}{2}, \frac{1}{4}, \frac{1}{4} \right\}$ The total information of all the messages is

- a) 2 bits b) 3 bits
c) 4 bits d) 5 bits.

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iii) A Gaussian channel has a 10 MHz bandwidth of $S/N = 100$. The channel capacity is

- a) 66.59×10^6 bits/s
- b) 77.60×10^6 bits/s
- c) 55.48×10^7 bits/s
- d) 44.37×10^6 bits/s.

iv) Which of the following statements is true regarding the Hamming weight of a code word ?

- a) It is the total number of elements in the code words.
- b) It is the total number of zero elements in the code words.
- c) It is the total number of non-zero elements in the code words.
- d) None of these.

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- v) A Linear Block Code will always contain
- a) a negative code word.
 - b) all zero code word.
 - c) all one code word.
 - d) variable length individual code words.
- vi) A monic polynomial means
- a) its leading term coefficient is unity.
 - b) it is having all non-zero coefficients.
 - c) it is having degree one.
 - d) at least one coefficient of it is zero.
- vii) Which of the following statements is true regarding the cyclic code 'C' ?
- a) 'C' always contains variable length codes.
 - b) 'C' is also a linear code.
 - c) 'C' will not contain all one code word.
 - d) 'C' will not contain all zero code word.

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viii) The minimum distance of a RS code is

- a) $n + k + 1$ b) $n - k + 1$
- c) $n + k - 1$ d) $n - k - 1$.

ix) A primitive polynomial is a/an

- a) odd polynomial b) even polynomial
- c) prime polynomial d) none of these.

x) The constraint length of a shift register encoder is defined as

- a) the number of symbols input
- b) the number of symbols it can store in its memory
- c) the number of symbols output
- d) none of these.

xi) A (n, k) convolutional code has the word length

- a) $k = (m - 1) k_0$ b) $k = (1 - m) k_0$
- c) $k = (m + 1) k_0$ d) none of these.

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GROUP – B**(Short Answer Type Questions)**Answer any *three* of the following. $3 \times 5 = 15$

2. Define the efficiency of a prefix code. Calculate the efficiency of a source X which generates four symbols with probabilities $P(x_1) = 0.5$, $P(x_2) = 0.2$, $P(x_3) = 0.2$ and $P(x_4) = 0.1$. 2 + 3
3. Discuss some of the properties for a linear block code. What do you mean by Hamming Distance ? 3 + 2
4. What are the properties for a cyclic code ? Explain with example. Write one polynomial representing binary cyclic codes. 3 + 2
5. Consider a convolutional encoder described by its Generator Polynomial Matrix, defined over $GF(2)$:

$$G(D) = \begin{bmatrix} D & 0 & 1 & D^2 & D + D^2 \\ D^2 & 0 & 0 & 1 + D & 0 \\ 1 & 0 & D^2 & 0 & D^2 \end{bmatrix}$$

- i) Draw the circuit realization of this encoder using shift registers. What is the value of v ? 2 + 1
- ii) Is this a Catastrophic Code ? Why ? 2
6. Find the generator polynomial $g(x)$ for a double error correcting ternary BCH code of block length 8. What is the code rate of the code ?

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GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Discuss the Matrix representation of a (3, 2) Linear Block Code using your own chosen Generator Matrix. 5

- b) Briefly discuss the idea of Parity Check Matrix for the Linear Block Code. 5

- c) Explain the 'Nearest Neighbour Decoding' concept for the Linear Block Code. 5

8. a) Write down the division algorithm for the polynomials. Consider the two polynomials $f(x) = 1 + x^2$ and $g(x) = 1 + x + x^2$ over $GF(2)$, now calculate $f(x) + g(x)$. $3 + 2$

- b) Discuss a method for generating Cyclic Codes with suitable example. 5

- c) Let $f(x)$ is a polynomial in $F[x]$. Now discuss the reducibility or factorization concept of $f(x)$. Give suitable example to justify your answer. 5

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9. a) State and prove the theorem on Kraft inequality. 5
- b) Consider a DMS with source probabilities { 0.35, 0.25, 0.20, 0.15, 0.05 }.
- i) Determine the Huffman code for this source. 5
- ii) Determine the average length R of the code words. 3
- iii) What is the efficiency η of the code ? 2
10. a) Define channel capacity. 2
- b) State and prove channel capacity theorem. 1 + 5
- c) Explain the importance of Sh non limit. 3
- d) A telephone channel has a bandwidth of 3000 Hz and the SNR = 20 dB. Determine the channel capacity. If the SNR is increased to 25 dB, determine the increased capacity 2 + 2
11. Design a (12, 3) systematic convolutional encoder with a constraint length $\nu = 3$ and $d^* \geq 8$.
- i) Construct the Trellis Diagram for this encoder. 7
- ii) What is the d_{free} for this code ? 8

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