

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  $\frac{1}{4}$  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 S/N = 100. The channel capacity is
  - a)  $66.59 \times 10^{6}$  bits/s
  - b) 77.60  $\times$  10<sup>6</sup> bits/s
  - c)  $55.48 \times 10^{-7}$  bits/s
  - d)  $44.37 \times 10^{6}$  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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CS/B.Tech/CSE/NEW/SEM-6/ 013 A Linear Block Code will always contain a negative code word.

all zero code word. b)

v)

a)

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

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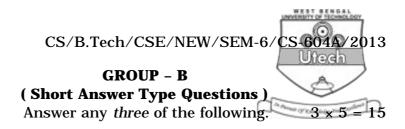


viii) The minimum distance of a RS code is



- 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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- 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
- 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):

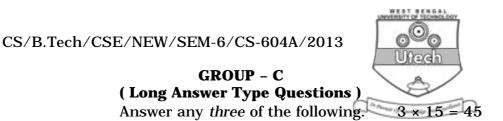
$$G(D) = \begin{bmatrix} D & O & 1 & D^2 & D + D^2 \\ D^2 & 0 & 0 & 1 + D & 0 \\ 1 & 0 & D^2 & 0 & D^2 \end{bmatrix}$$

- 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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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.

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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 $\eta$ of the code ? 2
10.	a)	Define channel capacity. 2
	b)	State and prove channel capacity theorem. $1 + 5$
	c)	Explain the importance of Shanon 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 $v = 3$ and $d^* > = 8$ .	
	i)	Construct the Trellis Diagram for this encoder. 7
	ii)	What is the $d_{free}$ for this code ?8

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