Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech/(ECE-New)/SEM-6/EC-604B/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) Entropy means

a) amount of information

b) rate of information

c) measure of uncertainty

d) probability of message.

ii) The ideal communication channel is defined for a system which has

a) finite C b) BW = 0

c) S/N = 0 d) infinite C.

iii) Which of the following expressions is incorrect ?

a) $H(Y/X) = H(X, Y) - H(X)$

b) $I(X, Y) = H(X) - H(Y/X)$

c) $H(X, Y) = H(X, Y) + H(Y)$

d) $I(X, Y) = H(Y) - H(Y/X)$.

iv) Relation between message rate (r) and information rate (R) is

a) $R = rH$ b) $r = RH$

c) $r = R^2H$ d) $R = r^2H$.

v) Relation between channel capacity and bandwidth of channel is related as

a) $C = B\left(ln_2(S/N)\right)$

b) $C = B\left(ln_2(1 + S/N)\right)$

c) $C = B/N$

d) $C = B^2N$.

vi) In any linear feed forward path of a (4, 3, 2) convolution encoder, we need maximum

a) 4 shift registers b) 3 shift registers

c) 2 shift registers d) none of these.

vii) For $GF\left(2^3\right)$ 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) $\{0\ 1\ 2\ 3\ 4\ 5\ 6\ 7\}$.

viii) A code is with minimum distance $d_{min} = 5$. How many errors can it correct ?

a) 3 b) 2

c) 4 d) 1.

ix) The number of undetectable errors for a (n, k) linear code is

a) 2^{n-k} b) 2^n

c) $2^n - 2^k$ d) 2^k.

x) The generator polynomial of a $(7, 4)$ cyclic code has the degree of

a) 2 b) 3

c) 4 d) 5.

xi) The syndrome polynomial in a cyclic code solely depends on

a) generator polynomial b) parity polynomial

c) error polynomial d) code word.

xii) A (63, 15) BCH code over $GF\left(2^6\right)$ can produce the code maximum error capability of

a) 6 b) 8

c) 10 d) 12.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

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

3. Prove that the entropy is maximum when the messages are equally likely.

4. Consider a source X which produces five symbols with probabilities 1/2, 1/4, 1/8, 1/16 and 1/16. Calculate source entropy.

5. Explain the concept of maximum likelihood decoding.

6. Design a generator matrix for a (7, 4) linear binary code (LBC).

7. Discuss the advantages and disadvantages of convolution codes.

GROUP – C
(Long Answer Type Questions)

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

8. a) Find the entropy of a source generating *n* number of messages having different probabilities of occurrence.

   b) State and explain source encoding theorem.

   c) An analog signal band limited to 10 kHz is quantized in 8 levels of a PCM system with probabilities 1/4, 1/5, 1/5, 1/10, 1/10, 1/20, 1/20, 1/20 respectively. Calculate entropy and the rate of information. 5 + 5 + 5

9. a) One parity check code has parity check matrix as :

$$H = \left| \begin{array}{ccc:ccc} 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 \end{array} \right|$$

   i) Determine generator matrix

   ii) Find the code word that begins with [101]

   iii) If received word is [110110], then decode this word.

   b) Show that the channel capacity for a continuous channel is given by $C = B \log_2 [1 + S/N]$ bit/sec.

(2 + 3 + 3) + 7

10. a) A (7, 1) repetition code used to encode information sent through a channel with a bit error probability of 0·01. Find the probability that an information bit is erroneous after coding.

b) A channel has the following channel matrix :

$$[P(Y/X)] \begin{bmatrix} 1-P & P & 0 \\ 0 & P & 1-P \end{bmatrix}$$

Draw the channel diagram. If the source has equally likely outputs, compute the probability associated with the channel outputs for p = 0·2s.

c) What is Galois Field ?

11. What is Hamming distance ? Give relation between minimum distance and error detecting and correcting capability. Describe a Hamming code. Also define Hamming sphere and Hamming bound.

12. a) For a systematic (7, 4) cyclic code determine the generator matrix and parity check matrix if $g(x) = 1 + x + x^3$.

b) A codeword polynomial $c(x)$, belonging to the (7, 4) code with $g(x) = x^3 + x + 1$, incurs error so giving the received polynomial $v(x)$. Find $c(x)$ when

i) $v(x) = x^5 + x^2 + 1$

ii) $v(x) = x^6 + x^3 + 1$. 7 + 8

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

a) Viterbi decoding

b) Turbo codes

c) Dual codes

d) Standard array decoding

e) BCH codes.