



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.

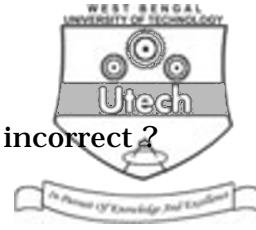
GROUP – A

(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) $C = B (\ln_2 (S/N))$

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

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

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

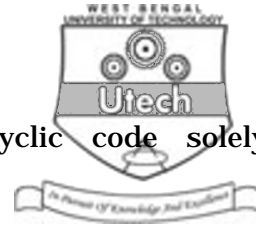
- a) 3
- b) 2
- c) 4
- d) 1.

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 $GF(2^6)$ 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.

$3 \times 15 = 45$

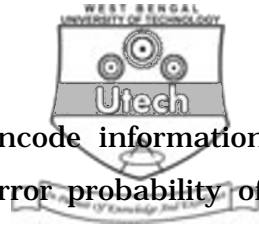
8. a) Find the entropy of a source generating n number of messages having different probabilities of occurrence.
- b) State and explain source encoding theorem.
- c) An analog signal band limited to 10 kHz is quantized in 8 levels of a PCM system with probabilities $1/4$, $1/5$, $1/5$, $1/10$, $1/10$, $1/20$, $1/20$, $1/20$ 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 $p = 0.2$.

- 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.

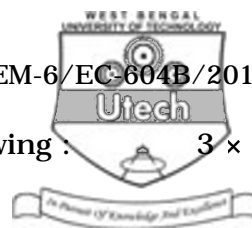
12. a) For a systematic (7, 4) cyclic code determine the generator matrix and parity check matrix if $g (x) = 1 + x + x^3$.

- 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.

=====