# WEST BENGAL UNIVERSITY OF TECHNOLOGY

## EC-604B

## INFORMATION THEORY AND CODING

Time Allotted: 3 Hours | Full Marks: 70

*The questions are of equal value.*
*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. Answer *all* questions. 10×1 = 10

(i) 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) $2^k$

(ii) Entropy represents

(A) amount of information (B) rate of information
(C) measure of uncertainty (D) probability of message

(iii) The mutual information of a channel with independent input and output is

(A) zero (B) constant
(C) variable (D) infinite

(iv) In block coding, if $k = 2$ and $n = 3$, then number of invalid code words is

(A) 8 (B) 4
(C) 2 (D) 6





(v) 1 decit equals

(A) 1 bit (B) 3.32 bits
(C) 10 bits (D) none of these

(vi) If a telephone channel has bandwidth 3000Hz and SNR = 20dB then channel capacity is

(A) 3 kbps (B) 1.19 kbps
(C) 2.19 kbps (D) 19.97 kbps

(vii) For a noiseless channel I(X; Y) is

(A) H(X)-H(Y) (B) H(Y)-H(X)
(C) H(X) (D) H(X)-H(Y/X)

(viii) The condition of a dual code in case of linear block code is

(A) $GH^T = 0$ (B) $(GH)^T = 0$
(C) $G^TH^T = 0$ (D) $HG^T = 0$

(ix) A (7,4) linear block code with minimum distance guarantees error detection of

(A) ≤ 4 bits (B) ≤ 3 bits
(C) ≤ 2 bits (D) ≤ 6 bits

(x) The efficiency of Huffman code is linearly proportional to

(A) average length of the code (B) average entropy
(C) maximum length of the code (D) none of these

### GROUP B
### (Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. Draw the state diagram for (2, 1, 2) convolution code and explain. 5

3. Define the channel transition matrix and with suitable example show at least 3channel transition matrix. 5

4. $P(x_1) = 0.4$, $P(x_2) = 0.17$, $P(x_3) = 0.18$, $P(x_4) = 0.1$ and $P(x_5) = 0.15$ for 5 symbol $x_1$, $x_2$, $x_3$, $x_4$ and $x_5$. Construct a Shannon Fano code and find out its efficiency. 5

5. Explain Shannon Hartley law regarding channel capacity. What is mutual information? 5

6. Consider $g(x) = 1+x+x^3$ for a (7, 4) cyclic code. Find the generator matrix of systematic form. 5

## GROUP C
## (Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) Define code rate and block length. 3+2+10
   (b) Give diagrammatic representation of block encoder.
   (c) The generator matrix of a (7,4) block code is given by

$$\mathbf{G} = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

   (i) Find **H**, the parity check matrix of the code
   (ii) Find the syndrome for the received vector 1101101. Is this a valid code vector?
   (iii) Find all code words of the code.
   (iv) What is error correcting capability of the code?
   (v) What is error detecting capability of the code?

8. (a) What are cyclic codes? Why are they called subclass of block code? 5+4+6
   (b) Write the advantages and disadvantages of cyclic code.
   (c) Prove that the generator polynomial $f(x)$ of an $(n, k)$ cyclic code is a factor of $1 + x^n$.









9. (a) Find the generator polynomial of a triple error correcting BCH code with block length $n = 31$ over $GF(2^5)$. 8+7
   (b) What are the advantages of turbo code? Discuss how it is implemented?

10. (a) What do you mean by entropy of a source and mutual information of a communication channel? (2+3)+5+(2+3)
   (b) Consider a source $X$ which produces five symbols with probabilities $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, and $\frac{1}{16}$. Find the source entropy.
   (c) Briefly discuss about the channel capacity of a discrete memoryless channel. Determine the channel capacity of a noiseless channel.

11. Write short notes on any *three* of the following: 3×5
   (a) Standard array decoding
   (b) Golay code
   (c) Huffman coding
   (d) Cyclic burst
   (e) Viterbi decoding.