



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/M.TECH(ECE)/SEM-2/MCE-203/2010  
2010**

**ERROR CONTROL CODING THEORY**

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.*

Answer Question No. 1 and any 4 from the rest.

1. Select the correct answers and give *one* line justifications :

$$7 \times 2 = 14$$

a) The random error correction capability of a ( 7, 4 ) linear Hamming code is

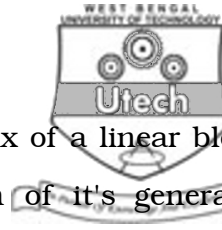
i) 7                                      ii) 4

iii) 3                                      iv) 1.

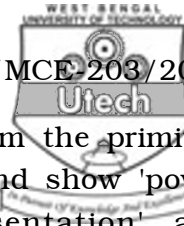
b) If in a ( 15, 7 ) linear block code, the minimum weight of any valid code word is 5, the minimum distance between any two of them will be

i) 5                                      ii) 15/5

iii)  $7 \times 5$                                       iv)  $15 - 7$ .



- c) If dimension of the parity check matrix of a linear block code is  $(8 \times 15)$ , then dimension of its generator matrix is
- i)  $(15 \times 8)$                       ii)  $(7 \times 15)$   
iii)  $(15 \times 7)$                       iv)  $(7 \times 8)$ .
- d) The constraint length of a convolutional encoder made of 5 shift register is
- i) 5                                      ii) 7  
iii) 6                                      iv) 4.
- e) In a convolutional encoder, the fractional rate loss for a 100 bit input message in comparison to a 50 bit input message will be almost
- i) 2 times                              ii)  $1/2$  times  
iii)  $2^2$  times                              iv) same.
- f) The generator polynomial  $g(x)$  of a  $(7, 4)$  cyclic code is a factor of
- i)  $x^7 + 1$                               ii)  $x^4 + 1$   
iii)  $x^3 + 1$                               iv)  $x^7$ .
- g) When a 5 bit message is given to the input of a  $(3, 3, 1)$  convolutional encoder, length of the coded output is
- i) 24 bits                              ii) 25 bits  
iii) 15 bits                              iv) 45 bits.



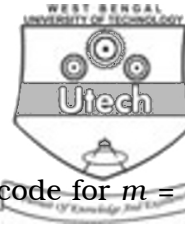
2. a) Derive the elements of  $GF(2^4)$  from the primitive polynomial  $P(x) = x^4 + x^3 + 1$  and show 'power representation', 'polynomial representation' and 'n-tuple representation' of the elements. 5
- b) Show that  $\alpha^5$  is not a primitive element of the above group. 3
- c) What do you understand by conjugate roots? 2
- d) Find the parity matrix  $H$  for a double error correcting BCH code based on the above  $P(X)$ . 4
3. a) Explain the structural relation between generator matrix and parity check matrix of a linear block code. 5
- b) Hence determine the parity check matrix from the generator matrix given below : 3

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

- c) Find the code word  $v$  when the message  $u = (1111)$ . 3
- d) How is the code word related to the parity check matrix? Prove the relation for the code word  $v$  found above. 3
4. a) Explain the principle of error detection and correction in linear block codes. 6
- b) The generator matrix of a linear block code is given as,

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

Design an error detection and correction circuit explaining the important design steps. 8



5. a) Explain what is a linear Hamming code. 4  
 b) Give the parity matrix  $H$  of a Hamming code for  $m = 3$ . 3  
 c) Explain what are BCH codes. 4  
 d) Show that a single error correcting BCH code is in fact a Hamming code. 3
6. a) Draw the syndrome circuit for a  $(7, 4)$  cyclic code generated by  $g(X) = 1 + x^2 + x^3$  and explain it's operation when the erroneous received vector  $r = (0101001)$ . 7  
 b) Draw and explain the Megitt detector for the same cyclic code and determine the corrected vector for the same erroneous received vector  $r$ . 7
- 7.

Dia.

- a) Construct the state diagramme for above convolutional encoder. 4  
 b) If the input message is  $u = (10101)$ , determine the output  $v$  by tracing it's path through the state diagramme. 3  
 c) Illustrate with an example how a primitive polynomial can be used as the generator polynomial to produce a maximum length PN sequence using linear feedback shift registers. 7

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