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) 7×5 iv) $15 - 7$.

c) If dimension of the parity check matrix of a linear block code is (8 × 15), then dimension of it's generator matrix is

i) (15 × 8) ii) (7 × 15)

iii) (15 × 7) iv) (7 × 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-tupple representation' of the elements. 5

b) Show that α^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