



Name :

Roll No. :

Invigilator's Signature :

CS/M.Tech(ECE)/SEM-2/MCE-202/2012
2012
ERROR CONTROL 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)

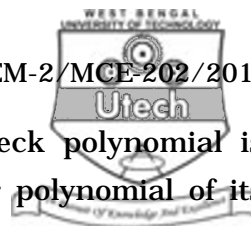
1. Choose the correct alternatives for any *ten* of the following :
 $10 \times 1 = 10$

i) For (7, 4) Hamming code, the parity-check bits for information words (i_1, i_2, i_3, i_4) is

- a) $i_1 + i_2 + i_3$ b) $i_1 + i_3 + i_4$
c) $i_1 + i_2 + i_4$ d) both (a) and (b).

ii) For even parity (5, 4) block code, p_c for $p = 0.1$ is

- a) 0.5905 b) 0.5815
c) 0.5616 d) 0.5915.



viii) In a (7, 4) code, if the parity check polynomial is $x^4 + x^2 + x + 1$, then the generator polynomial of its dual code is

- a) $x^3 + x^2 + x + 1$ b) $x^4 + x^2 + x + 1$
 c) $x^4 + x^3 + x^2 + x$ d) $x^4 + x^3 + x + 1$.

ix) The dimension of the subspace in V_5 consisting of the vectors (00000), (11100), (01010), (10001), (10110), (101101) and (00111) is

- a) 3 b) 2
 c) 4 d) 5.

x) The generator polynomial of $GE(2^4)$ is $x^4 + x + 1$. If α^7 is a root of this polynomial belonging to $GF(2^4)$, then the minimal polynomial will be

- a) $x^4 + x + 1$ b) $x^4 + x^2 + 1$
 c) $x^4 + x^3 + 1$ d) $x^3 + x + 1$.

xi) Which of the following codes belongs to non-binary BCH code ?

- a) Cyclic code b) Block code
 c) Hamming code d) Reed-Solomon code.

xii) Previous inputs are considered in which of the following code ?

- a) Convolution code b) BCH code
 c) Reed-Solomon code d) None of these.



GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

3 × 5 = 15

2. Show that the following linear codes are not cyclic :

a) The (6, 3) code with generator matrix

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

b) The (5, 2) code with generator matrix.

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

3. What is Galois field ? Why is it called field ? Give reason and example in support of your answer.
4. What do you mean by vector space ? What are called linear dependent and independent vector spaces ? How can you find the dimension of a vector space and the basis of a vector space ?
5. Find the minimal polynomials for α , α^2 and α^3 which are the roots of $x^4 + x + 1 = 0$ in $GF(2^4)$.
6. Construct a triple error-correcting BCH code with block length $n = 31$ over $GF(2^5)$, the generator polynomial in $GF(2^5)$ is $g(x) = x^5 + x^2 + 1$.



GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Show that the row space of the matrix

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

gives the codewords of the (5, 3) linear code.

- b) Show that every codeword in the (7, 3) code is orthogonal to every other codeword.

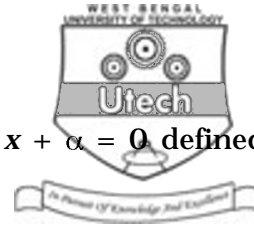
- c) What do you mean by dual code ? Give example.

$6 + 6 + 3$

8. a) Determine whether the polynomials

$$p_1(x) = x^4 + x^3 + x + 1, \quad p_2(x) = x^2 + x + 1,$$

$p_3(x) = x^3 + x^2 + 1$ over $GF(2)$ are (i) irreducible and (ii) primitive.



- b) Find the roots of $x^3 + \alpha^8 x^2 + \alpha^{12} x + \alpha = 0$ defined over $GF(2^4)$.

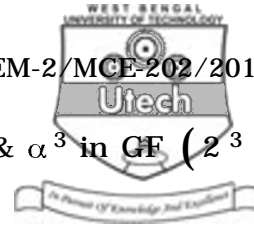
- c) Determine the inverse of the matrix

$$A = \begin{bmatrix} \alpha^{12} & 0 & \alpha \\ 1 & \alpha^8 & \alpha^{14} \\ \alpha^2 & \alpha^{11} & \alpha^5 \end{bmatrix}$$

over $GF(2^3)$ and $GF(2^4)$.

6 + 3 + 6

9. a) Determine a linear feedback shift register for dividing by the polynomial $p(x) = x^5 + x^3 + x + 1$. By considering the operation of the register, determine the remainder and quotient of $x^7 + x^2 + 1$ divided by $p(x)$. Check your answer using the 'long hand' method for polynomial division.
- b) Draw and explain the operation of an encoder circuit for $(7, 4)$ cyclic code with $g(x) = x^3 + x + 1$. 8 + 7
10. a) Construct a single error-correcting binary BCH code over $GF(2^3)$.



- b) Given the minimal polynomials of α & α^3 in $\text{GF}(2^3)$ are $m_1(x) = x^5 + x^2 + 1$ and

$m_3(x) = x^5 + x^4 + x^3 + x^2 + 1$ respectively, construct a binary double error-correcting code over $\text{GF}(2^5)$.

- c) Determine the generator polynomial of the double error-correcting (15, 11) Reed-Solomon codes. $5 + 5 + 5$

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

- a) Reed-Solomon code
- b) Convolutional code
- c) Berlekamp algorithm
- d) Cyclic code
- e) Vector space.

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