



Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/M. Tech (ECE)/SEM-2/MCE-202/2013**

**2013**

**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**

1. Answer any *ten* of the following : 10 × 1 = 10
  - a) A code with minimum distance  $d(\min) = 5$ . How many errors it can correct ?
  - b) Which degree of generator polynomial can generate a (7, 4) Cyclic code ?
  - c) What is the factor of a generator polynomial of a Cyclic code ?
  - d) What is the memory order of an encoder of ( 4, 3, 2 ) convolution code ?
  - e) What is the length of a BCH code ?
  - f) What are the numbers of shift registers in ( 2, 1, 2 ) convolution code ?

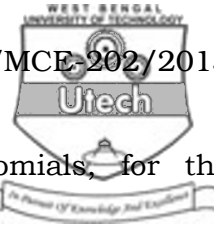


- g) What is the condition of a dual code in case of Linear Block code ?
- h) What are the differences between single error and burst error ?
- i) Definition of Block code
- j) What is Hamming code ?
- k) What is Linear code ?
- l) What is Cyclic code ?

**GROUP – B**

Answer any *three* of the following :  $3 \times 5 = 15$

- 2. A (7, 1) repetition code is 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 decoding.
- 3. Consider the (4, 3) even-parity code with the 8 codewords. (0000), (0011), (0110), (1100), (0101), (1010), (1001), (1111). Show that the code is linear.
- 4. Consider the (8,4) extended Hamming code. Determine the outcome of a decoder when the codeword  $c = (00101101)$  incurs the errors
  - a)  $e_1 = (00100000)$
  - b)  $e_2 = (10000100)$
  - c)  $e_3 = (00000111)$



5. Determine nonsystematic codeword polynomials, for the (7, 4) code, given  $i_1 = (1100)$  and  $i_2 = (1001)$ .
6. Assuming the (7, 4) Cyclic code, determine the systematic codeword polynomials for  $i_1 = (1001)$  and  $i_2 = (1110)$ .

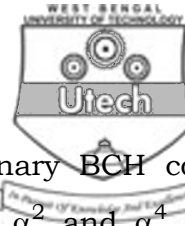
**GROUP - C**

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

7. a) Construct a Linear Feedback Shift Register for dividing  $x^7 + x^6 + x^2 + x + 1$  by  $x^4 + x^2 + 1$ .
- b) Solve the following equations over the prime field modulo-5  
 $2x + 3y = 1$   
 $x + 2y = 2$
- c) Given that  $\alpha$  is a field element of  $GF(2^3)$  evaluate  
 i)  $(\alpha^2 \alpha^{-5} + 1)(\alpha^2 + \alpha)$   
 ii)  $\sqrt{(\alpha^4 \alpha^5 + \sqrt{\alpha})}$ .

Repeat when  $\alpha$  an element of  $GF(2^4)$  is.  $6 + 3 + 6$

8. a) Determine whether the polynomials  
 $P_1(x) = x^4 + x^3 + x + 1$   
 $P_2(x) = x^2 + x + 1$   
 $P_3(x) = x^3 + x^2 + 1$   
 Over  $GF(2)$  are (a) irreducible and (b) primitive.
- b) Determine systematic and nonsystematic code words for  $i = (0\ 1\ 1\ 1)$  given the (7, 4) code with  $g(x) = x^3 + x + 1$ .  $8 + 7$



9. a) The (15, 11) single-error-correcting binary BCH code has  $g(x) = x^4 + x + 1$ . Show that  $\alpha, \alpha^2$  and  $\alpha^4$  are roots of  $g(x)$  but  $\alpha^3$  is not a root, where  $\alpha$  is a primitive field element of  $GF(2^4)$ . Find the fourth root of  $g(x)$ .

b) Find the determinant of the matrix

$$A = \begin{bmatrix} 1 & \alpha^4 & \alpha^3 \\ \alpha^2 & 0 & \alpha \\ \alpha^4 & \alpha & \alpha^5 \end{bmatrix}$$

Over  $GF(2^3)$  and  $GF(2^4)$  8 + 7

10. a) Construct the (15, 13) single-error-correcting reed-solomon code and determine the systematic codeword corresponding to  $i = (0\ 0\ \alpha\ 0\ 0\ 1\ \alpha^7\ \alpha^2\ 0\ 0\ 1\ \alpha\ \alpha^2)$  where  $\alpha$  is a primitive element of  $GF(2^4)$ .

b) Show that  $\alpha, \alpha^2, \alpha^3$  and  $\alpha^4$  are roots of  $g(x) = x^8 + x^7 + x^6 + x^4 + 1$ , the generator polynomial of the (15, 7) double-error-correcting binary BCH code, where  $\alpha$  is a primitive element field of  $GF(2^4)$ . 8 + 7

11. a) Design a shift register with stages and  $g_0 = 1, g_1 = 0, g_2 = 1, g_3 = 1$ . Determine the output sequence for the input sequence  $u = (1001)$ .

b) Determine the output sequence from the (4, 3, 2) convolution encoder, given the input sequences  $u^1 = (101), u^2 = (110)$  and  $u^3 = (011)$ . 8 + 7