

## GANPAT UNIVERSITY

M. Tech. Semester II (EC) Examination, May/June 2012  
Error Control Codes

Max. Time: 3 Hrs.]

[Max. Marks: 70

**Instructions:**

1. Attempt **all** questions.
2. Answers to the two sections must be written in separate answer books.
3. Figures to the **right** indicate full marks.
4. Assume suitable data, if necessary.
5. Question numbers three and six are compulsory.

**SECTION-I**

- 1 (A) Define the field elements of finite field  $F_4$  and find the addition and multiplication table for the same. 4
- (B) Prove the following: 6
- i. If a  $q$ -ary  $(n, M, d)$  code exists with  $d \geq 2$ , there also exists an  $(n-1, M, d-1)$  code.
  - ii. In a symmetric channel with error probability  $p > 0$ , a code  $C$  can detect up to  $t$  errors in every codeword  $\Leftrightarrow d(C) \geq t + 1$ .
- (C) Define the Hamming bound. 2

OR

- 1 (A) Let the general form of a polynomial over  $Z_5$  (of degree 2) be  $f(x) = x^2 + ax + b$ ,  $a, b \in Z_5$ . For different values of  $a$  and  $b$  find the polynomials which are irreducible in  $F_5$ . 6
- (B) List the elements of  $F_8/x^3+x^2+1$  and find the addition and multiplication table for the same. 6
- 2 (A) Consider a linear  $(5,4,3)$  codes  $c_1=(0\ 0\ 0\ 0\ 0)$ ,  $c_2=(0\ 1\ 1\ 0\ 1)$ ,  $c_3=(1\ 0\ 1\ 1\ 0)$  and  $c_4=(1\ 1\ 0\ 1\ 1)$ . Show the following: 9
- i. This coding scheme has minimum Hamming distance equal to 3.
  - ii. This scheme can correct one single error and two fixed double errors.
  - iii. Using syndrome decoding find the correct codeword if received vector is: 01111, 11101 and 01011.
- (B) What is the difference between convolutional and block codes. 2

OR

- 2 (A) Describe the Peterson-Gorenstein-Zierler algorithm for decoding the BCH codes. 8
- (B) How to construct the Reed Solomon code? 3

- 3 (A) Construct a (15, 7) BCH code having a Hamming distance of 5 in the field

$$F_{2^4}: F(x)/x^4 + x + 1.$$

- (B) Find the elements of the field  $F_{2^5}$  on base of polynomial  $x^5 + x^2 + 1$ .

2

### SECTION II

- 4 (A) Draw the structure of convolutional code having a generator matrix  $G = [101, 111]_2$ . Using the appropriate input construct the trellis diagram. Also draw and find the systematic form of the convolutional encoder for the same. 10

- (B) What is a catastrophic encoder in convolutional codes.

2

OR

- 4 (A) Draw the diagram of a rate 2/3 convolutional encoder with generator matrix

$$G(x) = \begin{bmatrix} 1+x & x & 1 \\ x^2 & 1 & 1+x+x^2 \end{bmatrix}. \text{ Convert this to systematic convolutional code. Using suitable message polynomial find the codeword polynomial.}$$

8

- (B) Construct the systematic generator matrix for Hamming code from the (7,4) cyclic code with the polynomial  $g(x) = 1 + x + x^3$ .

4

- 5 (A) Give the factors of  $x^{15} - 1$  over  $F_2$ .

6

- (B) Write short note on Iterative decoding of Turbo codes.

5

OR

- 5 (A) Using suitable example explain the Space Time Codes.

6

- (B) Using suitable example explain the RSC encoder used in Turbo codes.

5

- 6 (A) Write short note on Viterbi decoding.

6

- (B) What is interleaving? Explain some common types of interleaving used in wireless communication.

6

END OF PAPER