GANPAT UNIVERSITY

M. Tech. Semester II (EC) Examination, June/July 2013
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)** Show that finite field F_4 is not Modulo 4 field. 4

(B) For any q ary code with code word length prove the following: 6

i. Size of the codebook $A_q(n, 1) = q^n$

ii. Size of the codebook $A_q(n, n) = q$

(C) Define a perfect code. 2

OR

1 **(A)** List the elements of F_8/x^3+x+1 and find the addition and multiplication table for the same. 6

(B) 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

2 **(A)** Consider the linear (7, M, d) binary code C generated by 9

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \end{bmatrix}$$, find the following:

i. Find the parity check matrix H for C.

ii. Determine the maximum codeword M and minimum Hamming distance d, justify your answer.

iii. Is C a perfect code? Justify your answer.

iv. Suppose the vector 011011 is received. Can this vector be decoded, assuming that only one error has occurred? If so, what was the transmitted vector?

(B) List the conjugacy classes in GF(2^5) with respect to GF(2). 2

OR

2 **(A)** Construct a (15, 7) BCH code having a Hamming distance of 3 in the field 9

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

(B) Give difference between block code and convolutional code. 2

3 (A) Consider the generator matrix $G = \begin{bmatrix} 1 & 1 & 1 & 0 \\ 2 & 0 & 1 & 1 \end{bmatrix}$ in F_3. Find the following: 9

i. Convert matrix G into the standard form and find the parity check matrix H.

ii. For the received vectors (2121), (1201) and (2222) find the correct codeword.

(B) State and prove the sphere packing bound. 3

SECTION II

4 (A) Find the systematic (7,3) cyclic codes for the generator polynomial $g(x) = 1 + x + x^4$. 6

(B) Using suitable example explain the Viterbi decoding used in convolutonal codes. 6

OR

4 (A) Construct the systematic generator matrix for Hamming code from the (7,4) cyclic code with the polynomial $g(x) = 1 + x + x^3$. 8

(B) What is a catastrophic encoder in convolutional codes? Explain using suitable example. 4

5 (A) Draw the diagram of a rate 2/3 convolutional encoder with generator matrix $G(x) = \begin{bmatrix} 1 & 0 & \frac{x}{1+x^3} \\ 0 & 1 & \frac{x^2}{1+x^3} \end{bmatrix}$. Convert this to systematic convolutonal code. Using suitable message polynomial find the codeword polynomial. 6

(B) Write short note on Space Time Codes. 5

OR

5 (A) What is Recursive Systematic Coder? Explain using suitable example. 4

(B) Explain Trellis Coded Modulation. 7

6 (A) Write short note on decoding of Turbo coded data. 6

(B) What is interleaving? Explain some common types of interleaving used in wireless communication. 6

END OF PAPER