Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – II • EXAMINATION – SUMMER • 2013

Subject code: 1724103 Date: 03-06-2013

Subject Name: Error Control Coding in Communication

Time: 10.30 am – 01.00 pm Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** i) Prove that no two n-tuples in the same row of a standard array are identical and every n-tuple appears in one and only one row. **03**

ii) Prove that the minimum distance of a linear block code is equal to the minimum weight of its nonzero code words and vice versa. **04**

(b) Consider a systematic (7,4) linear block code for which the syndrome digits are given by **07**

$s_1 = r_1 + r_4 + r_6 + r_7$,

$s_2 = r_2 + r_4 + r_5 + r_6$,

$s_3 = r_3 + r_5 + r_6 + r_7$.

i) Find the generator matrix and parity check matrix for this code.

ii) Show that the error correcting capability of this code is one.

iii) Draw encoding and decoding circuits for this code.

iv) Is the vector 1 0 0 1 1 1 1 is code word? If no, then correct it and decode it.

Q.2 **(a)** i) Prove that the nonzero code polynomial of minimum degree in cyclic code C is unique. **03**

ii) For the (7,4) single error correcting cyclic code , $g(x) = 1 + x + x^3$. Construct generator matrix and parity check matrix for nonsystematic and systematic code. **04**

(b) The generator polynomial for a (15,7) cyclic code is **07**

$$G(x) = 1+x^4+x^6+x^7+x^8$$

i) Find the code-vector is systematic form for the message $d(x) = 1+x^2+x^3+x^4$

ii) Assume that the second and last bit of the code vector v(x) for $d(x) = 1+x^2+x^3+x^4$ suffer transmission errors. Find syndrome of v(x).

iii) Construct the Meggitt decoder for the same.

OR

(b) Design a feedback shift register encoder for (8,5) cyclic code with generator matrix $g(x)=1+ x+ x^2+ x^3$. Use the encoder to find the codeword for the massage 1 0 1 0 1 in systematic form. Using Meggitt decoder circuit, correct the single error in the received vector 1 0 0 1 1 1 1 0. **07**

Q.3 **(a)** Explain role of Interleaver and Deinterleaver system for bursty noise. **07**

(b) Consider primitive polynomial $f(x) = 1+ x+ x^3$ for m=3 **07**

i) Define a set of elements $\{0, \alpha^0, \alpha^1, \alpha^2, \ldots\ldots, \alpha^{2^m-2}\}$ in terms of basis elements from the finite field GF (2^m).

ii) Develop an addition table.

iii) Develop a multiplication table.

iv) Find the generator polynomial for the (7,3) R-S code.

OR

Q.3 **(a)** Write a short note on : BCH code **07**

(b) Use a LFSR to encode the symbols {6, 5, 1} with a (7,3) R-S code in systematic form. Show the resulting codeword in binary form. Verify the encoding results by evaluating the codeword polynomial at the roots of the (7, 3) R-S generator polynomial g(x). Use primitive polynomial f(x) = 1+ x+ x^3. **07**

Q.4 **(a)** Explain encoding of convolution code using transfer domain approach with an example. **07**

(b) Draw the state diagram, three diagram and trellis diagram for the convolution encoder characterized by the block diagram shown in Fig.1.Using this encoder find code word for information sequence 10110 and also decode receive sequence 1010100101 using Viterbi decoding algorithm. **07**

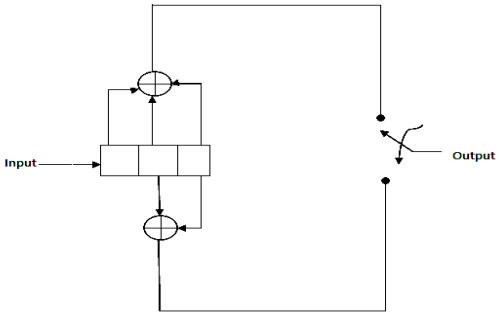

Fig.1

OR

Q.4 **(a)** Explain Trellis diagram with example. **07**

(b) For the convolution encoder shown in Fig.2, The information sequence is d=110011. Find the output sequence using time domain approach and transfer domain approach. **07**

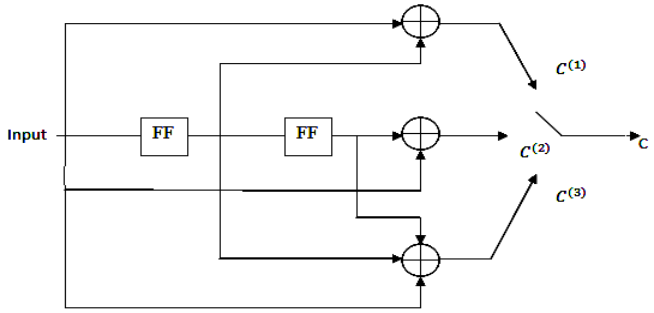

Fig.2

Q.5 **(a)** i) Give the difference between block code and convolution code. **04**

ii) Explain different types of error in communication. **03**

(b) Fig.3 shows RSC encoder, using this construct Turbo code. The interleaver permutation is given by [6, 3, 8, 9, 5, 7, 1, 4, 10, 2]. The message bit sequence to encode is m= 0110010110 with leftmost bit entering the encoder first. Find out encoded output sequence. **07**

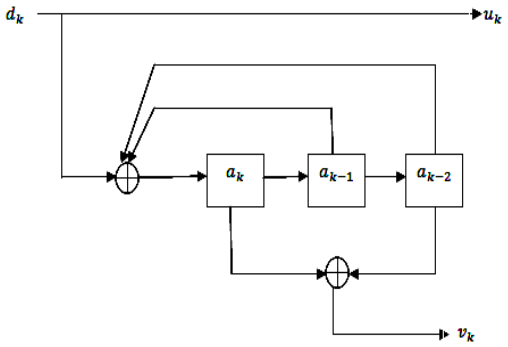

Fig.3

OR

Q.5 **(a)** What do you mean by shorten cyclic code? Explain briefly with example. **07**

(b) The expurgated (n,k-1) hamming code is obtained from the original (n,k) hamming code by discarding some of the code vectors. Let g(x) denotes the generator polynomial of the original hamming code. The most common expurgated hamming code is the one generated by **07**

$$g_1(x) = (1+x)\, g(x)$$

where (1+x) is factor of $1+x^n$

consider the (7,4) hamming code generated by

$$g(x)=1+x^2+x^3$$

i) Determine the generator matrix G_1 and parity check matrix H_1 of the expurgated (7, 3) hamming code, assuming the systematic format.

ii) Construct the eight code vectors in the expurgated (7, 3) hamming code. Hence, show that the minimum distance of the code is 4.

iii) Devise the encoder for the expurgated hamming code and list the shift register contents in a tabular fashion for the message 011.

iv) Device the syndrome calculation circuit for expurgated hamming code. Hence determine the syndrome for the received vector 0111110. Also correct the error using error correction circuit in the received vector.

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