Student Exam No.____________

GANPAT UNIVERSITY

B. Tech. Semester: VII EC Engineering

CBCS Regular Examination November – December 2014

2EC701 INFORMATION THEORY AND CODING

Time: 3 Hours **Total Marks: 70**

Instruction:

1. All questions are compulsory.
2. Write answer of each section in separate answer books.
3. Figures to the right indicate marks of questions.
4. Standard terms and notation are used.

SECTION I

Q-1 **(A)** A source having 8 symbols with respective probabilities of 0.22, 0.20, 0.18, 0.15, 0.10, 0.08, 0.05 and 0.02. Construct a ternary Huffman code and determine the code efficiency. **[06]**

(B) A transmitter has 5 symbols $\{a_1, a_2, a_3, a_4, a_5\}$ and the receiver has four symbols $\{b_1, b_2, b_3, b_4\}$. The joint probabilities $P(A, B)$ of the system are given. **[06]**

$$P(A,B) = \begin{bmatrix} 1/5 & 0 & 0 & 0 \\ 3/40 & 9/40 & 0 & 0 \\ 0 & 1/15 & 2/15 & 0 \\ 0 & 0 & 1/30 & 1/15 \\ 0 & 0 & 1/5 & 0 \end{bmatrix}$$

Find the following terms:
$H(A), H(B), I(A,B)\ H(B/A)$ and $H(A/B)$

OR

Q-1 **(A)** Write a short note on trellis coded modulation. **[06]**

(B) For a binary symmetric channel (BSC). Find $H(X), H(Y), H(X/Y),\ H(Y/X)$ and $I(X/Y)$. Let $P(y_1/x_1) = 2/3, P(y_2/x_1) = 1/3, P(y_1/x_2) = 1/10, P(y_2/x_2) = 9/10,$ $P(x_1) = 1/3,$ and $P(x_1) = 2/3$. **[06]**

Q-2 Consider the primitive polynomial $p(z) = z^3 + z^2 + 1$ over $GF(2)$. Construct the extension field $GF(8)$ and take $\alpha = z$ be the primitive element. Find elements of $GF(8)$ as power of α and the corresponding minimal polynomial and give the generator polynomial double error correcting BCH code. **[11]**

OR

Q-2 **(A)** A message source generates one of four messages randomly every 1 microsecond. The probabilities of these messages are 0.6, 0.05, 0.05 and 0.3. Each emitted messages independent of the other messages in the sequence. **[06]**

(i) What is source entropy?

(ii) What is the rate of information generated by this source (in bits per second)?

(B) Prove that the entropy for a discrete source is a maximum when the output symbols are equally probable. **[05]**

Q-3 **(A)** Consider a source with 6 symbols with respective probabilities of 0.30, 0.25, 0.15, 0.12, 0.10 and 0.08. Construct a binary Huffman code and determine the code efficiency. **[06]**

(B) Prove the following statements: **[06]**

(i) Two statistically independent events do not provide mutual information.

(ii) When two events are identical then mutual information becomes self-information.

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SECTION II

Q-4 **(A)** For a (6,3) code, the generator matrix **G** is given as: **[0**

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

For all possible data words, find the corresponding code words, and verify that this code is a single error correcting code.

(B) Explain Encoding and decoding of turbo codes with neat and clean diagram. **[06]**

OR

Q-4 **(A)** For a (6, 3) systematic linear block code, the tree parity-check digits C_4, C_5 and C_6 are **[06]**

$$C_4 = d_1 + d_2 + d_3 \qquad C_5 = d_1 + d_2 \qquad C_6 = d_1 + d_3$$

(i) Construct the appropriate generator matrix for this code.

(ii) Construct the code generated by this matrix.

(iii) Decode the following received code words: **101100, 000110, 101010**

(B) Answer the following questions: **[06]**

(i) Consider the (23, 12, 7) binary code. Show that if it is used over a binary symmetric channel (BSC) with probability of bit error $p = 0.01$, the word error will be approximately 0.00008

(ii) Prove that for any (n, k) cyclic code generator polynomial $g(x)$ must be one of the prime (irreducible) polynomial.

Q-5 For the convolution encoder shown in figure 1 draw the state, trellis and tree diagrams and determine the output sequence for data digits 1011 **[11]**

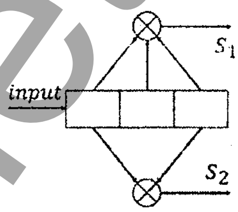

figure 1

OR

Q-5 For the convolution encoder shown in figure 2 draw the state, trellis and use vterbi decoding for following received sequence **[11]**

100 110 111 101 001 101 001 010

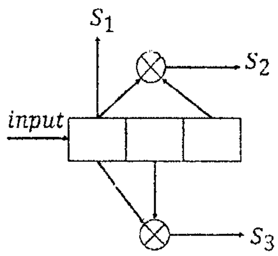

figure 2

Q-6 **(A)** Consider a (7,4) code whose generator matrix is **[06]**

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

(i) Find out codewords for given data words: 1001, 1000, 0111, 1111and 1011.

(ii) Is a (7, 4) code a perfect code? Justify your answer.

(B) Construct the decoding table for the single error correcting (7,4) code (use $g(x) = x^3 + x^2 + 1$). Determine the data vectors transmitted for the following received vectors **[06]**

(i) 1101101 (ii) 0101000 (iii) 0001100

END OF PAPER