Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

SEVENTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION
NOV/DEC 2015
SUBJECT: INFORMATION THEORY AND CODING [ECE-407]

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates

- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A. A certain data source has 8 symbols that are produced in blocks of four at a rate of 500 blocks/sec. The first symbol in each block is always the same. The remaining three are filled by any of the 8 symbols with equal probability. What is the entropy rate of this source?

1B. A zero memory source contains X = {x_1, x_2, x_3} with P(X) = { ½, ¼, ¼ }. Find the entropy of this source. Also determine the entropy of its second extension and verify that $H(S^2) = 2H(S)$.

1C. Probability that a student passes an examination, given that he has studied, is 0.9. The probability that he passes the examination without studying is 0.2. Assume that the probability of the student studying for the exam is 0.6. What is the amount of information you receive if you are told that the student has passed the examination. Further, what is the information you receive if you are told that he studied for the exam?

(4+4+2)

2A. Which of the sets of word lengths shown below are acceptable for uniquely decodable code when the code alphabet is X={0,1,2}

(i) Code A with 11 symbols of word lengths 1,2,2,2,2,3,3,3,3,3,3

(ii) Code B with 11 symbols of word lengths 1,1,2,2,3,3,4,4,5,5,5

Construct an instantaneous code if lengths are acceptable.

2B. Prove that the average length L of a compact code for a zero memory source with q symbols, can never be less than the ratio of the source entropy and log r, where r is the number of symbols in the code alphabet set.

2C. Explain adjoint of a Markov Information source with an example.

(5+3+2)

3A. Find $H(\overline{S^2})$ for the first order Markov source shown in figure Q3A.

3B. Construct a minimum variance quarternary Huffman code for the message "**electronics_engineer**". Compute the code efficiency.

(5+5)

4A. Decode the sequence"**00000001111010001011000000100**" using adaptive Huffman coding algorithm for the source with 26 letter alphabet (a to z).

4B. Consider a zero memory source S = {s_1, s_2, s_3, s_4, s_5, s_6, s_7} with probabilities {0.4, 0.2, 01, 0.1, 0.1, 0.05, 0.05}. Construct a minimum variance binary Huffman code and determine the efficiency of the code.

4C. A source S has six symbols with probabilities P_1 to P_6, respectively. Assume that we have ordered the P_i so that $P_1 \geq P_2 \geq \ldots\ldots \geq P_6$. We wish to find a compact code for this source using the code alphabet X = {0, 1, 2, 3}. Find a set of word lengths for such a compact code if P_6=1/64.

(5+3+2)

5A. The input source to a noisy communication channel is a random variable X over the four symbols a, b, c, d. The output from this channel is a random variable Y over these same four symbols. The joint distribution of these two random variables is as follows:

$$\begin{bmatrix} \frac{1}{8} & \frac{1}{16} & \frac{1}{16} & \frac{1}{4} \\ \frac{1}{16} & \frac{1}{8} & \frac{1}{16} & 0 \\ \frac{1}{32} & \frac{1}{32} & \frac{1}{16} & 0 \\ \frac{1}{32} & \frac{1}{32} & \frac{1}{16} & 0 \end{bmatrix}$$

Compute the H(X),H(Y), H(X/Y), H(Y/X), H(X,Y) and I(X;Y) in bits.

5B. Two BSCs, each with error probability 0.1, are cascaded as shown in the figure Q5B. The inputs 0 and 1 are chosen with the probabilities 0.4 and 0.6 respectively. Compute mutual information and the capacity of this channel.

5C. A binary erasure channel has the probability of error as 0.01. If the input symbols are equiprobable, identify its equivocation.

(5+3+2)

6A. The parity check matrix of a (7, 4) linear block code is given by,

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

How many correctable error patterns are there in this code? What is the minimum distance of this code? Suppose that the code word, **v** = (1001011) is transmitted and **r** = (1001111) is received, compute the syndrome of **r**. Develop the generator matrix for this code.

6B. Define the following with respect to linear block codes: (i) Hamming distance, (ii) Hamming weight (iii) Syndrome.

6C. Obtain the lower and upper bounds of the mutual information of an r-ary uniform communication channel.

(5+3+2)

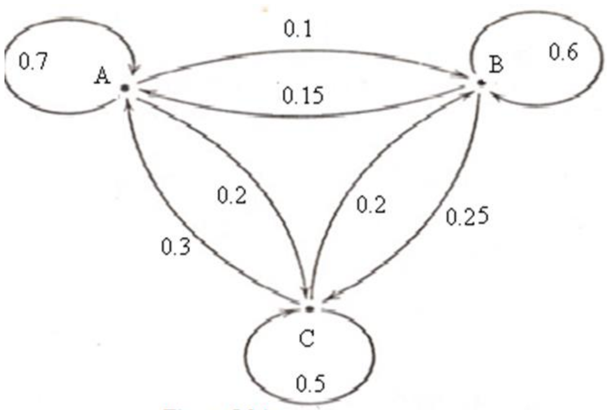

Figure Q3A

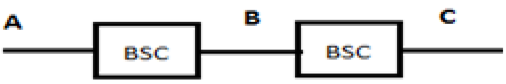

Figure Q5B