Paper Code: EC-407 **Roll No.**

B.Tech.

(SEM IV) EVEN SEMESTER EXAMINATION, 2015-16

INFORMATION THEORY & CODING

[Time: 3 hrs.] **[Max. Marks: 100]**

Note- Attempt All Questions. All Questions carry equal marks.

1. Attempt any four parts of the following:- **[5x4=20]**

(a) Relate the amount of information provided and probability of occurrence of events with suitable example.

(b) A discrete source emits one of five symbols once every milliseconds with probabilities1/2, 1/4, 1/8, 1/16 and 1/16. Find the source entropy and information rate.

(c) Define mutual information I (X; Y) and show that I (X; Y) $\geq$ 0.

(d) What is source coding? Define code length & code efficiency. Give the relation between it.

(e) Define Generator matrix G and Parity checkmatrix H and show that G. $H^T = 0$.

(f) Define the terms coding efficiency and redundancy.

2. Attempt any four parts of the following:- **[5x4=20]**

(a) State and prove Kraft's inequality and define the prefix condition.

(b) Explain with example.

(i) What are instantaneous codes?

(ii) What are the block codes?

(c) Give the relation between channel capacity C, bandwidth W and signal to noise ratio S/N of a AWGN channel. Explain the trade-off between them.

(d) Define(i) Joint entropy; and (ii) Conditional entropy, for a continuous channel.

(e) Explain about arithmetic coding.

(f) Define binary symmetric channel and write its channel matrix.

3. Attempt any two parts of the following:- **[10x2=20]**

(a) Define (i) Discrete entropy H (X), H(Y) and joint entropy H (X,Y) and

(ii) Mutual information I(X; Y).

(iii) Show that I (X; Y) = H (X) + H (Y) - H (X, Y).

(b) Construct the Huffman code with minimum code variance for the following probabilities and also determine the code variance and code efficiency:

{0.25, 0.25. 0.125, 0.125, 0.125, 0.0625, 0.0625}

(c) Consider a (6,3) linear block code whose generator matrix is given by

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

(i) Find the parity check matrix.
(ii) Find the minimum distance of the code.
(iii) Draw the encoder and syndrome computation circuit.

4. Attempt any two parts of the following **[10x2=20]**

(a) A (7, 4) cyclic code has a generator polynomial: $g(X) = X^3 + X + 1$.
(i) Draw the block diagram of encoder and syndrome calculator.
(ii) Find generator and parity check matrices in systematic form.

(b) A Memory less source emits seven messages with probabilities {0.4, 0.2, 0.12, 0.08, 0.08, 0.08, 0.04}. Find the Shannon - Fano code and determine its efficiency.

(c) A BSC has the error probability p = 0.2 and the input to the channel consists of 4 equiprobable messages $x_1 = 000$; $x_2 = 001$; $x_3 = 011$; $x_4 = 111$. Calculate
(i) p(0) and p(1) at the input
(ii) Efficiency of the code
(iii) Channel capacity

5. Attempt any two parts of the following **[10x2=20]**

(a) Consider that two sources emit messages x_1, x_2, x_3 and y_1, y_2, y_3 with the joint probabilities *p (X, Y)* as shown in the matrix form:

$$p(X,Y) = \begin{bmatrix} 3/40 & 1/40 & 1/40 \\ 1/20 & 3/20 & 1/20 \\ 1/8 & 1/8 & 3/8 \end{bmatrix}$$

(i) Calculate the entropies of X and Y.
(ii) Calculate the joint and conditional entropies, H (X, Y), H (X/Y), and H (Y/X) between X and Y.
(iii) Calculate the average mutual information I(X;Y).

(b) Consider (3, 1, 2) convolutional code with g (1) = (110), g (2) = (101) and g (3) = (111):
(i) Draw the encoder block diagram.
(ii) Find the generator matrix.
(iii) Find the code word corresponding to the information sequence (11101) using time domain approach.

(c) What is a Markoff information source? What is the use of the tree diagram representation for such a source? Define the term entropy and information rate of Markoff sources.