Enrollment No: _____ Exam Seat No:_____

C.U.SHAH UNIVERSITY
Winter Examination-2015

Subject Name: Information Theory & Coding

Subject Code: 5TE01ICT1 **Branch: M.Tech (EC)**

Semester: 1 **Date:21/12/2015** **Time: 10:30 To 1:30** **Marks: 70**

Instructions:

(1) Use of Programmable calculator and any other electronic instrument is prohibited.
(2) Instructions written on main answer book are strictly to be obeyed.
(3) Draw neat diagrams and figures (if necessary) at right places.
(4) Assume suitable data if needed.

SECTION – I

Q-1 **Attempt the following questions** **(07)**

a. What is Deterministic Signals?
b. What is Random Signals?
c. Define Mean.
d. Define Variance.
e. Define Standard Deviation.
f. What is Central Moment?
g. What is Random Processes?

Q-2 **Attempt all questions** **(14)**

(a) A card is drawn randomly from a regular deck of cards. Assign probability to the event that the card drawn is (i) a red card (ii) A black queen (iii) a picture card including ace card (iv) a number card with number 7 (v)a number card with number ≤ 5.

(b) Find the CDF of the Gaussian Random Variable whose PDF is given by

$$f_X(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}$$

OR

Q-2 **Attempt all questions** **(14)**

(a) A random variable X has an exponential PDF given by $f_x = a \cdot e^{-b|x|}$ where 'a' and 'b' are constants. Find (i) relation between 'a' and 'b' (ii) Distribution function of x (CDF) (iii) Find out probability that outcome lies between 1 and 2.

(b) The joint PDF of random variable *(x,y)*is given by,

$$f_{xy}(x,y)=K(x+y) \text{ for } 0<x<2,\ 0<y<2$$

Find the value of k, and conditional PDF.

Q-3 **Attempt all questions** **(14)**

(a) Explain Stationary and Non-stationary Random Processes in detail.

(b) Explain Transmission of random process through linear system in detail.

OR

Q-3 **Attempt all questions** **(14)**

(a) Write a note on Ergodic Processes.

(b) State and prove the Central Limit Theorem.

SECTION – II

Q-4 **Attempt the Following questions** **(07)**

a. Define Uniquely Decodable Code.

b. Define Instantaneous Code.

c. Define Prefix Code.

d. What is Rate of Information?

e. What is Hamming Distance?

f. What is Code Rate?

g. What is Constraint Length?

Q-5 **Attempt all questions** **(14)**

(a) State and prove the Kraft's inequality theorem with an example.

(b) A source emits three equiprobable messages randomly and independently. (i) Find the source entropy. (ii) Find a compact ternary code, the average length of the code word, the code efficiency, and the redundancy. (iii) Repeat part (ii) for a binary code. (iv) To improve the efficiency of a binary code, we now code the second extension of the source. Find a compact binary code, the average length of the code word, the code efficiency, and the redundancy.

OR

Q-5 **Attempt all questions** **(14)**

(a) Given a telegraph source having two symbols, dot and dash. The dot duration is 0.2 sec. The dash duration is 3 times the dot duration. The probability of dot's occurring is twice that of the dash, and time between symbols is 0.2 sec. Calculate the information rate of the telegraph source.

(b) Verify the following property of entropy $0 \le H(X) \le \log_2 m$, where m is the size of the alphabet of X.

Q-6 **Attempt all questions** **(14)**

(a) Derive the equation of channel capacity for a Binary Erasure Channel.

(b) A rate ½ convolution encoder with constraint length 3 is described by $g1(x) = 1+x+ x^2$ and $g2(x) = 1+ x^2$. Draw the trellis diagram for this encoder and encode the message 10111.

OR

Q-6 **Attempt all Questions** **(14)**

(a) Write a note on Viterbi Convolution Decoding Algorithm.

(b) A binary channel matrix is given by

$$\begin{array}{c} \\ x_1 \\ x_2 \end{array} \begin{array}{c} \begin{array}{cc} y1 & y2 \end{array} \\ \begin{bmatrix} 2/3 & 1/3 \\ 1/10 & 9/10 \end{bmatrix} \end{array} \qquad \begin{array}{l} x1, x2 = input \\ y1, y2 = output \end{array}$$

P(x1) = 1/3 and P(x2) = 2/3. Determine H(X), H(X/Y), H(Y), H(Y/X) and I(X; Y).