Roll No. ..... Total Pages : 3

BT-5/D-20 **45245**

INFORMATION THEORY AND CODING

Paper : EC-307A

Time : Three Hours] [Maximum Marks : 75

Note : Solve any *five* questions.

1. Let a fair die (i) rolled. Let the random variable is defined as $X(i) = 5i$, where i is the output of the die experiment.

(a) Determine and plot CDF, cumulative distribution function. 6

(b) Determine and plot the PDF, probability density function. 6

(c) Define CDF and PDF and their properties. 3

2. (a) Probability density function of a random variable X is $f(x) = ke^{-5|x|}$; $-\infty < x < \infty$. Find (i) CDF $F(x)$ (ii) value of k (iii) $P(-1 \leq x \leq +1)$. 7

(b) What is Poison's distribution ? Obtain an expression for it variance and mean. 5

(c) Define and explain random processes with the help of examples. 3

3. Explain the following in detail :

(a) Uniquely decodable codes.

(b) Instantaneous codes and its construction.

(c) Markov sources. 5,5,5

4. (a) A source generates eight messages $\{m_1, m_2, ...m_8\}$ with the corresponding probabilities

$$\left\{\frac{1}{4}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8}, \frac{1}{16}, \frac{1}{16}, \frac{1}{16}, \frac{1}{16}\right\}.$$

(i) Obtain the Shanon-Fano codes. 4

(ii) Determine efficiency of this code. 3

(iii) Determine the probability of $p(0)$ of 0 occurring. 3

(b) Explain and prove additivity property of entropy of a discrete memoryless source. 5

5. (a) Define the channel capacity. 5

(b) Define a binary symmetric channel and obtain an expression for its channel capacity. 10

6. (a) A channel is defined by the following matrix. Determine its channel capacity $\begin{bmatrix} \frac{1}{3} & \frac{2}{3} \\ \frac{2}{3} & \frac{1}{3} \end{bmatrix}$. 8

(b) Explain and prove noiseless coding theorem. 7

7. (a) Explain and prove the channel coding theorem.

(b) Explain the properties of block codes.

8. A convolutional encoder has a single shift register with two stages, three modular adders. The generator sequences of the encoder are

$$g^{(1)} = (1, 0, 1)$$
$$g^{(2)} = (1, 1, 0)$$
$$g^{(2)} = (1, 1, 1).$$

(a) Draw the block diagram of the code. 3

(b) Obtain the generator matrix. 3

(c) Draw the code tree. 4

(d) Obtain the trellis diagram. 5

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