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Paper Code : PE-EC603D Information Theory & Coding

UPID : 006752

Time Allotted : 3 Hours *Full Marks :70*

The Figures in the margin indicate full marks.
Candidate are required to give their answers in their own words as far as practicable

Group-A (Very Short Answer Type Question)

1. Answer *any ten* of the following : [1 x 10 = 10]

(I) Write the relation between nat and bits.

(II) Calculate the information in bits for a message of probability 1/16.

(III) What is the channel capacity of a lossless channel having M symbols?

(IV) In a binary system will the coding efficiency increase or decrease on probability of 0 approaching 0.5?

(V) What will be the relation between message rate (r) and information rate (R)?

(VI) Can you comment on code rate of any coding scheme, whether greater or less than unity?

(VII) What is the Hamming distance between equal code words?

(VIII) A binary memoryless system produces two messages with probabilities p and 1 – p. When will be the entropy maximum?

(IX) Which parameter is called as Shannon limit?

(X) How many maximum shift registers are required in any linear feed forward path of a (4, 3, 2) convolution encoder?

(XI) Explain the mutual information for a Binary Symmetric Channel?

(XII) What is the probability of error for M equally likely messages, M>>1, if the rate of information R > C?

Group-B (Short Answer Type Question)

Answer *any three* of the following : [5 x 3 = 15]

2. With a suitable example explain the concept of efficiency of the source encoder. [5]

3. (a) Define information (E) [5]
   (b) Write the properties of information (E)

4. Show that $0 \leq H \leq \log_2 m$, where m is the size of the alphabet of X [5]

5. The generator matrix for a (6, 3) block code is given below. Find the code vector of the message bit 110. [5]
   Calculate the weight of this code vector

$$\begin{Bmatrix} 1\ 0\ 0 : 0\ 1\ 1 \\ 0\ 1\ 0 : 1\ 0\ 1 \\ 0\ 0\ 1 : 1\ 1\ 0 \end{Bmatrix}$$

6. A Gaussian channel has a bandwidth of 1 MHz. Compute the channel capacity if the signal power to noise spectral density ratio (S/η) is 105 Hz. Also calculate the maximum information rate [5]

Group-C (Long Answer Type Question)

Answer *any three* of the following : [15 x 3 = 45]

7. (a) Explain the terms and their significance: Self-information, Conditional Self-information, Average Mutual information, Prefix code [2+2+2+2]

   (b) State and prove Kraft inequality. [7]

8. Write short notes on: (a) BSC, (b) BEC, (c) Noiseless channel [5+5+5]

9. (a) State and prove source coding theorem. [10]
   (b) An analog signal band limited to 10 kHz is quantized in 4 levels of a PCM system with probabilities P(x1)=0.5, P(x2)=0.3, P(x3)=0.1 and P(x4)=0.1. Calculate entropy and the efficiency of the code. [5]

10. (a) For (15, 10) cyclic code, given D = 1010001101, P = 110101. Calculate Frame Check Sequence in the received word, where the symbols have their usual meanings. [5]

(b) A (7, 4) cyclic code is generated by $g(X)=1+X+X^3$. Find the generator and parity-check matrix in systematic form. [10]

11. (a) What is the use of syndrome and how is it computed? Compute the error syndrome for the (7, 4) linear code whose parity check matrix is [4+6]

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

(b) Also design the syndrome circuit for the code. [5]

*** END OF PAPER ***