MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

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) When will be the entropy of information source maximum?

(II) What is the capacity of the ideal communication channel?

(III) A code is with minimum distance $d_{min} = 5$. How many errors can it detect?

(IV) What is the relation of information (m_k) of a message m_k with probability p_k ?

(V) For a (n,k) code what is the value of code rate?

(VI) A code is with minimum distance $d_{min} = 5$. How many errors can it correct?

(VII) What is the conditional probability for an error free channel?

(VIII) What is a monic polynomial?

(IX) What is a Deterministic Channel?

(X) What is the capacity of a Binary Symmetric Channel?

(XI) What is the capacity of a communication channel with a bandwidth of 4 kHz and 15 SNR?

(XII) For generator polynomial $g(x) = 1 + x^2 + x^3$ of a (7, 4) cyclic code the message word u = (1010). Find the code vector.

Group-B (Short Answer Type Question)

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

2. Verify that I(X; Y) = I(Y; X) [5]

3. (a) Explain channel capacity theorem. [5]
(b) Define channel capacity of the discrete memoryless channel.

4. An analog signal having bandwidth B Hz is sampled at the Nyquist rate and the samples are quantized into four levels Q_1, Q_2, Q_3, and Q_4 with probabilities of occurrence $p_1 = p_2 = 3/5$, and $p_3 = p_4 = 2/5$, respectively. The quantization levels are assumed to be independent. Find the information rate of the source. [5]

5. Consider Table illustrating two binary codes having four symbols. Compare their efficiency. (M) [5]

x_j	$P(x_j)$	code 1	code 2
x_1	0.5	00	0
x_2	0.25	01	10
x_3	0.125	10	110
x_4	0.125	11	111

6. A telegraph source produces two symbols, dash and dot. The dot duration is 0.2 s. The dash duration is 2 times the dot duration. The probability of the dots occurring is twice that of the dash, and the time between symbols is 0.1 s. Determine the information rate of the telegraph source. [5]

Group-C (Long Answer Type Question)

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

7. (a) Consider a DMS with four source symbols encoded with four different binary codes as shown in Table. Show that all codes except code 2 satisfy the Kraft inequality [10]

x_j	code 1	code 2	code 3	code 4
x_1	0	00	0	0
x_2	01	10	11	100
x_3	10	11	100	110

x_4	11	110	110	111

(b) codes 1 and 4 are uniquely decodable but codes 2 and 3 are not uniquely decodable [5]

8. State and prove Shannon-Hartley law. [15]
9. Let an alphabet consist of only four symbols A, B, C and D with probabilities of occurrence P(A) = 0.2, P(B) = 0.2, P(C) = 0.4 and P(D) = 0.2. Find the arithmetic code for the message ABCCD [15]
10. An analog signal having 3 kHz bandwidth is sampled at 1.5 times the Nyquist rate. The successive samples are statistically independent. Each sample is quantized into one of 256 equally likely levels. [3+3+5+4]
    (a) Find the information rate of the source.
    (b) Is error-free transmission of the output of this source is possible over an AWGN channel with a bandwidth of 10 kHz and SNR of 20 dB.
    (c) Find the SNR required for error-free transmission for part (b).
    (d) Determine the bandwidth required for an AWGN channel for error-free transmission of the output of this source when the SNR is 20 dB
11. (a) Suppose a TV displays 30 frames/second. There are approximately 2 X 105 pixels per frame, each pixel requiring 16 bits for colour display. Assuming an SNR of 25 dB calculate the bandwidth required to support the transmission of the TV video signal. [5+5+5]
    (b) An 8 kHz communication channel has an SNR of 30 dB. If the channel bandwidth is doubled, keeping the signal power constant, calculate the SNR for the modified channel.
    (c) Consider an optical communication system operating at λ 800 nm. Suppose, only 1% of the optical source frequency is the available channel bandwidth for optical communication. How many channels can be accommodated for transmitting audio signals requiring a bandwidth of 8 kHz?

*** END OF PAPER ***