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Paper Code : EC-604B

INFORMATION THEORY AND CODING

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP - A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any ten of the following : 10 x 1 = 10
- i) Relation between channel capacity and bandwidth of channel is related as
- a) $C = B (\ln 2 (S/N))$
 - b) $C = B (\ln 2 (1 + S/N))$
 - c) $C = B/N$
 - d) $C = B * N$.
- ii) A code is with minimum distance 5. How many errors can it correct ?
- a) 3
 - b) 2
 - c) 4
 - d) 1.

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- iii) In the expression of Kraft Inequality, the value of K is given by

a) $K = \sum_{j=1}^m 2^{-n_j} \geq 1$

b) $K = \sum_{j=1}^m 2^{-n_j} \leq 1$

c) $K = \sum_{j=1}^m 2^{-n_j} = 1$

d) none of these.

- iv) The coding efficiency η is given by

a) $\eta = H(X) . L$

b) $\eta = H(X) / L$

c) $\eta = L/H(X)$

d) none of these.

- v) For $GF(2^2)$ the elements in the set are

a) { 1 2 3 4 5 6 7 }

b) { 0 1 2 3 4 5 6 }

c) { 0 1 2 3 }

d) { 0 1 2 3 4 5 6 7 }.

- vii) For a Reed-Solomon code, the minimum distance is

a) $n + k - 1$

b) $n - k + 1$

c) $k - n - 1$

d) $k - n + 1$.

- viii) The code rate for (15, 5) code is

a) 3

b) 1/3

c) 5

d) 10.

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

viii) For a (7, 4) cyclic code generated by

$g(x) = x^3 + x + 1$. The syndrome for error pattern $e(x) = x^3$ is

- a) 101 b) 111
- c) 110 d) 011.

ix) Which among the below stated logical circuits are present in encoder and decoder used for the implementation of cyclic codes ?

- A) Shift register
- B) Modulo-2 adders
- C) Counters
- D) Multiplexers.

- a) A and B b) C and D
- c) A and C d) B and D.

x) The generator polynomial of a cyclic code is factor of

- a) $X^n + 1$ b) $X^{(n+1)} + 1$
- c) $X^{(n+2)} + 1$ d) $X^{(n-1)} + 1$.

xi) The capacity of a communication channel with a bandwidth of 4 kHz and 15 SNR is approx

- a) 20 kbps b) 16 kbps
- c) 10 kbps d) 8 kbps.

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2. What is Hamming distance ? Give relation between minimum distance and error correcting capability. Define Hamming bound. 3 + 2

3. Show that the channel capacity for a continuous channel is given by $C = B \log_2 (1 + \frac{S}{N})$ bit/sec.

4. What is Kraft inequality ? Prove that Kraft inequality should be satisfied for variable length source coding. 2 + 3

5. A DMS X has five symbols x_1, x_2, x_3, x_4 and x_5 with probability $P(x_1) = 0.4, P(x_2) = 0.17, P(x_3) = 0.18, P(x_4) = 0.1$ and $P(x_5) = 0.15$, respectively.

- a) Construct the Shannon-Fano code for X.
- b) Calculate the efficiency of the code. 2 + 3

6. What is irreducible polynomial ? What do you mean by polynomial over $GF(2)$. Prove that $f(X) = 1 + X + X^3$ is a irreducible polynomial over $GF(2)$. 2 + 3

GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Verify the following expression :
 $C_s = \log_2 m$
 Where C_s is the channel capacity of a lossless channel and m is the number of symbols in the channel.
- b) Given that AWGN channel with 4 kHz bandwidth and the noise power spectral density $\eta/2 = 10^{12}$ W/Hz. The signal power required at the receiver is 0.1 mW. Calculate the capacity of the channel.
- c) Define (i) Lossless and (ii) Deterministic channel.
- d) State and prove the Shannon-Hartley law of channel capacity. 3 + 3 + (2 + 2) + 5
8. a) For a systematic (7, 4) cyclic code determine the generator matrix and parity check matrix if
 $g(x) = x^3 + x + 1$.
- b) A codeword polynomial $c(x)$, belonging to the (7, 4) code with $g(x) = x^3 + x + 1$, incurs error so giving the received polynomial $v(x)$. Find $c(x)$ when
- i) $v(x) = x^5 + x^2 + 1$
- ii) $v(x) = x^6 + x^3 + 1$.

- c) Construct the encoder circuit for the (7, 3) code with $g(x) = x^4 + x^3 + x^2 + 1$ and input
 $i(x) = x^2 + x$. 5 + 6 + 4
9. a) One parity check code has parity check matrix as
 $H = 110 : 100$
 $101 : 010$
 $100 : 001$
- i) Determine generator matrix
- ii) Find the code word that begins with [100]
- iii) If received word is { 110011 }, then decode this word.
- b) Explain the RSA algorithm with examples. (3 + 3 + 3) + 6
10. a) Given that (7, 3) Cyclic code with
 $g(x) = x^4 + x^3 + x^2 + 1$. Construct its dual code.
- b) Find the generator polynomial $g(x)$ for a single error correcting binary BCH code of blocklength 31.
- c) Use the primitive polynomial $p(x) = x^5 + x^2 + 1$ to construct GF (32). 5 + 5 + 5

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11. Write short notes on any *three* of the following : 3 × 5

- a) Source Coding
- b) Hamming Code
- c) Trellis diagram
- d) Error control strategy
- e) Viterbi decoding.

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