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BIEL-023

B.Tech. – VIEP – ELECTRONICS AND COMMUNICATION ENGINEERING (BTECVI)

00596 **Term-End Examination**

June, 2016

BIEL-023 : INFORMATION THEORY AND CODING

Time : 3 hours *Maximum Marks : 70*

Note : *Attempt any* ***seven*** *questions. Assume missing data, if any, suitably. Use of scientific calculator is permitted.*

1. A source emits seven symbols x_1, x_2, ... x_7 with probabilities 0·35, 0·3, 0·2, 0·1, 0·04, 0·005, 0·005 respectively. Give Huffman coding for these symbols and calculate average bits of information and average binary digits of information per symbol. *10*

2. (a) Prove the code-word lengths of any uniquely decodable code must satisfy the Kraft inequality $\sum D^{-l_1} \leq 1$. *5*

(b) Let (X, Y) have the following joint distribution :

Y \ X	1	2
1	0	3/4
2	1/8	1/8

Find H(X), H(X/Y), H(Y), H(Y/X). 5

3. (a) Derive the relationship between entropy and mutual information. Draw a Venn diagram for that relation. 5

(b) Prove for non-negative numbers

$a_1, a_2, \ldots a_n$ and $b_1, b_2, \ldots b_n$,

$$\sum_{i=1}^{n} a_i \log \frac{a_i}{b_i} \geq \sum_{i=1}^{n} a_i \log \frac{\sum_{i=1}^{n} a_i}{\sum_{i=1}^{n} b_i}$$

with equality if and only if $\frac{a_i}{b_i}$ = constant. 5

4. (a) Prove, if $V_1, V_2, \ldots V_n$ is a finite alphabet stochastic process that satisfies the AEP, then there exists a source channel code with $P_e^{(n)} \to 0$, if $H(V) < C$. 5

(b) Show that any sequence of $(2^{nR}, n)$ codes with $\lambda^{(n)} \to 0$ must have $R \leq C$. 5

5. Consider a (7, 4) code whose generator matrix is

$$G = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}.$$

(a) Find all the code-words of the code.

(b) Find H, the parity-check matrix of the code.

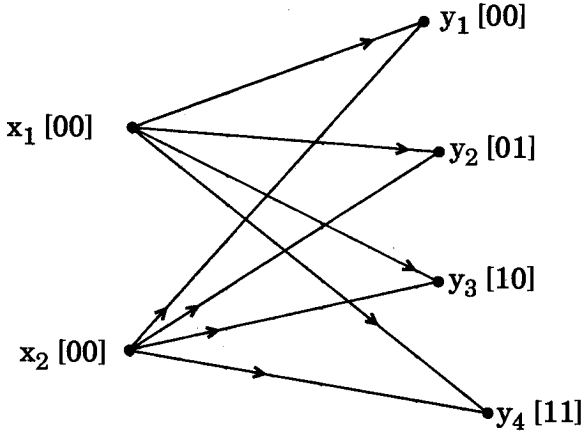
(c) Compute the syndrome for the received vector 1101101. *10*

6. What is the symbol-error correcting capability of a (7, 3) R-S code ? How many bits are there per symbol ? Compute the number of rows and columns in the standard array required to represent the (7, 3) R-S code. How much residual symbol-error correcting capability does it have ? *10*

7. For MPSK modulation, bandwidth efficiency increases with higher-dimensional signalling but for MFSK, it decreases. Explain the reason thereof. *10*

8. Explain Hamming code. How many Hamming bits are required for a block length of 20 message bits to correct a 1-bit error ? Demonstrate it with the help of an example. *10*

9. Calculate the rate of joint information transmission for the channel below:



Assume $p(x_1) = p(x_2) = \frac{1}{2}$, where $[X] = \{x_1, x_2\}$ is the set of input symbols.

Assume $q \rightarrow$ Probability of correct reception,

$p \rightarrow$ Probability of incorrect reception,

$[Y] = \{y_1, y_2, y_3, y_4\}$ be the set of received symbols. *10*

10. Write short notes on any ***two*** of the following : *2×5=10*

(a) Reed Solomon Codes

(b) Shannon's Channel Coding Theorem

(c) Characteristics of Finite Fields