UNIVERSITY OF THE WEST INDIES
CAVE HILL CAMPUS

Department of Computer Science, Mathematics & Physics

ELET2230 - Digital Communications 1

Class Test 1 **Thursday, October 29, 2020**

Please NOTE: this test has TWO pages

1. Consider the Discrete Memoryless Source (DMS) below:

Symbol	Probability
A	0.42
B	0.25
C	0.21
D	0.12

(a) What is the total amount of information contained in the message

ABDCBAB [3]

(b) What would be the average information expected for any message of the same length (seven symbols) ? [3]

(c) Suppose these symbols are always output in blocks of seven and messages are sent with a space of 3ms between them. What would be the source information rate if each symbol takes 1ms to transmit? [2]

(d) Determine the Huffman code for this DMS, the average code word length and the efficiency of the Huffman source encoder. [8]

(e) Determine the average number of binary digits/sec output from the encoder and compare it to the source information rate you calculated in part (c). How does this relate to Shannon's source coding theorem ? [4]

2. Use the Lempel-Ziv source coding algorithm to encode the binary stream

111101110011011101

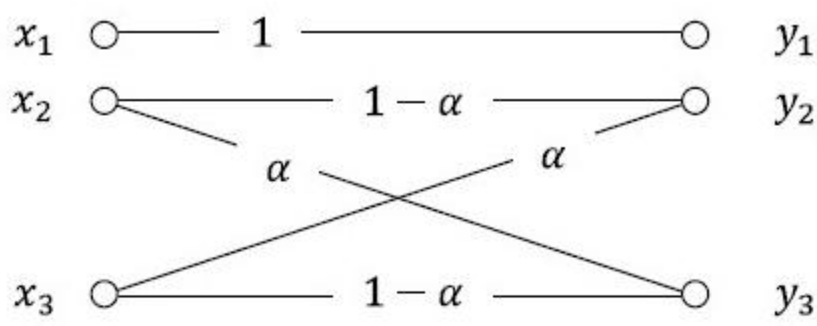
Be sure to use arrows and symbols to show what you are doing. If your output is longer than your input number of bits then explain why this has happened. [8]

3. For your assistance:

The average mutual information for a DMC is given by $I(X,Y) = H(Y) - H(Y|X) = \sum_j P(y_j)\log_2 \frac{1}{P(y_j)}$ - $\sum_j P(y_j|x_i)p(x_i)\log_2 \frac{1}{P(y_j|x_i)}$ bits/symbol.

Consider this Discrete Memoryless Channel (DMC) in which

$\mathrm{P}(x_1) = \mathrm{p},\ \mathrm{P}(x_2) = \mathrm{P}(x_3)$ and
$P(y_2|x_3) = P(y_3|x_2) = \alpha$



Now for the above DMC

$H(Y) = \Omega(\mathrm{p}) + 1\text{-p}$, where $\Omega(.)$ is the binary entropy function.

$H(Y|X) = (1-p)\Omega(\alpha)$

Determine and expression for the average mutual information $I(X,Y)$. [3]

Under what conditions will the average mutual information be equal to the source entrophy ? Verify your answer. [3]