Assessment 1

Assessment Number	1
Contribution to Overall Mark	10%
Submission Deadline	7 April, 2019, Sunday, Week 7

Assessment Objective

This assessment aims at evaluating students' understanding and problem solving skills involved in information theory, source coding and channel capacity analysis, which are accumulated during lectures, tutorials and after-class study.

Submission Procedure

Please submit one electronic copy on **ICE** and one hardcopy to the submission box in front of office **EE320**.

Marking Scheme

The specific marks assigned are shown on the right column of each question and sub-question.

<u>Question 1:</u> Entropy, Joint Entropy and Mutual Information *(25 points)*

Consider two random variables, X and Y with their joint probability mass function as follows:

$P(x, y)$	$y = 0$	$y = 1$	$y = 2$	$y = 3$
$x = 0$	1/8	1/24	1/24	1/24
$x = 1$	1/24	1/8	1/24	1/24
$x = 2$	1/24	1/24	1/8	1/24
$x = 3$	1/24	1/24	1/24	1/8

Determine the following (round your answers up to two decimals):

i) The marginal Entropies H(X) and H(Y). *(8 points)*
ii) The joint entropy H(X, Y). *(4 points)*
iii) The conditional entropies H(X|Y) and H(Y|X). *(8 points)*
iv) The mutual information between them I(X, Y). *(5 points)*

Question 2: Huffman Coding *(25 points)*

A discrete memoryless source has an alphabet X = {1, 2, 3} with symbol probabilities P(X) = {0.8 0.1, 0.1}.

i) Construct an *extended Huffman code* which encodes two source symbols at a time. *(10 points)*

ii) Calculate the average codeword length. *(4 points)*

iii) Calculate the coding efficiency of the extended Huffman code. *(6 points)*

iv) Compare coding efficiency of the original source and extended Huffman code. Interpret the significance of extended coding scheme. *(5 points)*

Question 3: Universal Source Coding (Lempel-Ziv Algorithm) *(25 points)*

Given the following binary sequence: 0100111110010100000101010110011011 1

i) Using the Lempel-Ziv algorithm to encode the sequence. *(15 points)*

ii) Demonstrate the decoding procedure. *(10 points)*

(Hint: Parse the sequence to determine the required fixed codeword length and fill the dictionary entries according to procedure.)

Question 4: Channel Capacity *(25 points)*

Consider the channels A and B as shown in the figure below.

i) Find the capacity of channel A. *(12 points)*

ii) Find the capacity of channel B. *(13 points)*

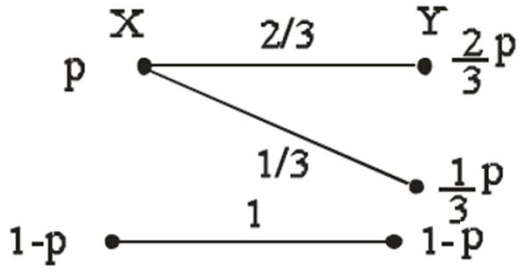

Figure 1 (a): Channel A

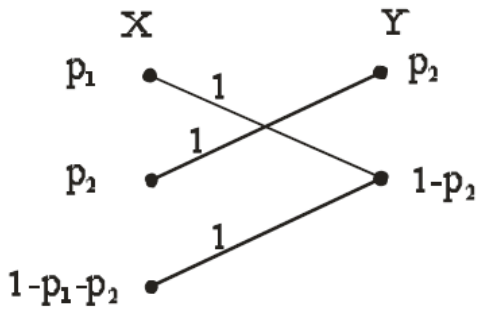

Figure 1 (b): Channel B