Sohag University
Faculty of Engineering
Electrical Engineering Dept.

Electronic & Comm Sec.
Information Theory and Coding
Sheet (4)

Q1) Consider the random variable

$$X = \begin{pmatrix} x_1 & x_2 & x_3 & x_4 & x_5 & x_6 & x_7 \\ 0.49 & 0.26 & 0.12 & 0.04 & 0.04 & 0.03 & 0.02 \end{pmatrix}.$$

(a) Find a binary Huffman code for X.
(b) Find the expected code length for this encoding.
(c) Find a ternary Huffman code for X.

Q2) Consider a random variable X that takes on four values with probabilities:-
$(\frac{1}{3}, \frac{1}{3}, \frac{1}{4}, \frac{1}{12})$.

(a) Construct a Huffman code for this random variable.
(b) Show that there exist two different sets of optimal lengths for the codewords; namely, show that codeword length assignments $(1, 2, 3, 3)$ and $(2, 2, 2, 2)$ are both optimal.
(c) Conclude that there are optimal codes with codeword lengths for some symbols that exceed the Shannon code length $\left\lceil \log \frac{1}{p(x)} \right\rceil$.

Q3) Find the (a) binary and (b) ternary Huffman codes for the random variable X with probabilities:-

$$p = \left(\frac{1}{21}, \frac{2}{21}, \frac{3}{21}, \frac{4}{21}, \frac{5}{21}, \frac{6}{21}\right).$$

(c) Calculate $L = \sum p_i l_i$ in each case.