CAIRO UNIVERSITY	**DEPT COMPUTER ENG**
FACULTY OF ENGINEERING	**Midterm Exam**
Graphics and Multimedia	**Time: 1.5 hours**

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1) Consider a source with the following symbol probabilities:

Symbol	Probabilities
s_0	0.32
s_1	0.27
s_2	0.16
s_3	0.14
s_4	0.11

a) Construct the Huffman code.

b) Find the average codeword length.

c) Find the entropy of the source (bits per symbol). Compare it with the average codeword length.

d) Is this code instantaneous?

e) Consider that an extended Huffman code is applied, taking three symbols at a time. *Without* constructing the code, find the lower and upper bound (i.e. the range) for the average codeword length.

2) Consider the source above with the symbol probabilities shown in the table above:

a) Assume that to correct for possible errors each symbol is transmitted three times in a row. For example, instead of sending $s_0s_3s_0s_1s_2$ we send $s_0s_0s_0s_3s_3s_3s_0s_0s_0s_1s_1s_1s_2s_2s_2$. What is the entropy (per symbol) for this situation.

b) Find the arithmetic code for sequence s_2s_2.

3)a) In what situation does the Huffman code produce an average length equal to the entropy.

b) Consider a source with N symbols, and assume we would like to construct a Huffman code. What is the minimum codeword length and the maximum codeword length that could be achieved (for any possible symbol probabilities).