EE3009 Tutorial 12

(Huffman Code and Digital Communications)

Problems

1. Consider the following data source X which generates symbols from the alphabet {A, B, C, D, E, F, G} with probabilities of occurrence shown in the following table:

A	B	C	D	E	F	G
0.49	0.26	0.12	0.04	0.04	0.03	0.02

   a) Find the entropy of this data source.
   b) If a fixed-length code is used, what is its average code length?
   c) Find a Shannon-Fano code for this data source. What is its average code length?
   d) Find a Huffman code for this data source. What is its average code length?
   e) Compare your answers in (a), (b), (c) and (d) What did you find?

2. Which of these codes cannot be Huffman codes for any probability assignment? Why?
   a) {0, 1, 11}
   b) {0, 10, 11}
   c) {00, 01, 10, 110}
   d) {01, 10}

3. Consider a low-pass communication channel of bandwidth 1 MHz. If Nyquist signaling rate is used to transmit 8-level pulses, what is the resultant bit rate?

4. Suppose that a signal has twice the power as a noise signal that is added to it.
   a) Find the SNR in decibels.
   b) Repeat if the signal has 2^n times the noise power.

5. Consider a channel with bandwidth 1 MHz. What is its Shannon capacity if the signal-to-noise ratio (SNR) is 20 dB? 40 dB?

6. Consider an analog repeater system in which there are n repeaters. For simplicity assume that each repeater recovers the original signal without distortion but that the noise accumulates. Suppose that the SNR after one repeater is 20 dB. Find the SNR after four repeaters. Express your answer in dB.