Problem Set 9

1. Given a data sequence

\[ 0 1 1 0 1 1 1 1 1 0 0 1 1 1 1 1 1 1 1 1 0 1 1 1 1 0 1 0 \]

what is the transmitted frame? Assume bit-oriented framing with a flag of $01^60$ signaling the end of the frame. Highlight the stuffed bits and the flag bits in the frame using a different colour.

2. Suppose the following string of bits is received:

\[ 01111111011110110011111001111101111101100011111101011110 \]

Assume the sender uses bit-oriented framing with a flag of $01^6$ (as usual, $01^60$ signals normal end of frame while $01^7$ signals abnormal termination). Remove the stuffed bits and show where the actual flags are.

3. Suppose frame lengths can vary from 8 bits to 1024 bits. In a length-based frame synchronisation approach we use a length field preceding the frame which tells the receiver how many bits there are in the frame that follows. If the frame lengths (in bits) are uniformly distributed, i.e., all lengths are equally likely, what is the expected overhead if a length field is used? What is the expected overhead if bit-oriented framing is used with an optimally chosen flag of the form $01^i$? What is the expected overhead if bit-oriented framing is used with the standard flag $01^6$?

4. A random source $X$ produces one of six symbols, say \{1, 2, 3, 4, 5, 6\}, with probabilities

\[ \Pr(X = i) \triangleq p_i = \frac{i}{2!} \quad (i = 1, 2, 3, 4, 5, 6). \]

Find the Huffman code for this source and calculate the average codeword length. Repeat for a source $X'$ which produces equally likely symbols

\[ \Pr(X' = i) \triangleq p'_i = \frac{1}{6} \quad (i = 1, 2, 3, 4, 5, 6). \]

Comment on the difference in the average codeword length.