Assignment 1

Due Tuesday, October 10. Show your work. Submit your assignment using the appropriate dropbox on the course web site. Assignments submitted after the solutions are made available will be given a mark of zero.

Question 1

A communication system transmits data generated by a wind direction sensor. There are four possible messages corresponding to the wind directions. At this location the wind blows from the East 45% of the time, from the West 30% of the time, from South 15% of the time, and from the North 10% of the time.

(a) What is the entropy of this message source in bits per message?

(b) If one wind direction report is generated every two seconds, what is the information rate of the source in bits per second?

(c) Assuming the best possible compression method was used, how many bits would be required to store an hour's worth of wind direction messages?

(d) How many bits would be required to store these messages if each direction was encoded using 2 bits per message?

(e) What are (i) the information rate and (ii) the data rate when each message is encoded using two bits per message?

Question 2

A communication system in a vehicle uses a 500 kb/s channel that is shared by 12 control units. Each message contains 32 bits of overhead for addressing and error control plus 8 bytes of data. There is a gap of 20 μs between messages. The different control units have different priorities and as a result one quarter of the messages are transmitted by the highest-priority unit. What is the throughput of the highest-priority unit in bits/second? Assume no messages are lost.

Question 3

Derive the UTF-8 encoding of the Unicode character "CANADIAN SYLLABICS SH" found in the Unicode code chart for "Unified Canadian Aboriginal Syllabics" (see http://www.unicode.org/charts/).

Show your work.

Question 4

(a) Consider the digits of your BCIT ID to be a number written in decimal (base 10) notation. Write this value as a 32-bit number using base-2 (binary) notation.

(b) Write the same number using base-16 (hexadecimal) notation.

(c) Show, in hexadecimal notation, the ordered sequence of bytes that would be stored or transmitted if using little-endian byte order.

(d) Show the sequence of bits that would be transmitted if these four bytes were transmitted l.s.b. first (with the bytes still in little-endian byte order).

Question 5

Some modems have asynchronous serial ("RS-232") interfaces. Many of these can be configured by sending command strings preceded by the character "AT". The modem automatically determines the serial interface speed from these first two characters.

Assume a modem's UART is set to 19200 bps, 8 bits/character and no parity. The character 'A' with 7 bits/character and no parity is sent to the modem at 4800 bps. What character(s) would the modem receive? Would there be any framing errors?

Assume the UART treats the first low-to-high transition after 8 data bits as the start of a start bit.