CSE 123: Computer Networks
Homework 1
Out: 09/30, Due: 10/07

Instructions:
1. Turn in a physical copy at the beginning of the class on 10/07.
2. Ensure the HW cover page has the following information clearly written:
   a. Name
   b. UCSD email
   c. PID
3. Please contact the TAs or post on Piazza to seek any clarification.
4. The homework is to be done individually.

1. Pluto with a heart
NASA's New Horizon, flying past Pluto, captured the iconic picture of Pluto's “Icy heart” which is of size 12MB. The bandwidth of the transmission link used is 1Kbps. The distance between Houston and New Horizon at that time is approximately 7.5 billion kilometers. Assume the speed of light in vacuum to be $3 \times 10^8$ m/s and that there is no loss of data (or retransmission) during transmission.

a) What is the total time elapsed between the start of transmission by New Horizon and the complete reception of the image at Houston?

b) Now assume New Horizon commences transmission of the image immediately after it receives a start instruction from Houston. There is no processing delay at New Horizon and the start instruction is sent from Houston via a packet of size 2KB. What is the total time elapsed between Houston sending the start instruction and the complete reception of the image?

c) Now let us assume New Horizon has clicked hundreds of pictures of Pluto and is ready to transmit data back to back non-stop. How many kilo bits of data would it transmit before Houston gets the first bit?

2. Cable modem
A cable modem transmits using 3KHz bandwidth channels. The receptor attached to the modem receives signal with a variable signal to noise ratio (SNR) which is at least 25dB during the day and at least 35dB during the night owing to the noisy days.

a) What is the maximum achievable channel capacity for the setup during the day and the night?

b) Shannon's Law states that $C$ is proportional to $B$ for a constant S/N ratio. Why should the channel capacity increase if we increase the channel bandwidth ($B$)? Give a qualitative argument. Note that channel bandwidth represents the frequency range at which the channel is being operated.

3. Ideal receiver
Suppose you are designing a receiver which should be able to read all the symbols (bits) being transmitted (that is, not lose any information). The receiver is to be connected to a channel which can allow a maximum frequency $f$.

What should be your minimum sampling rate of the incoming data to ensure no loss of information? Give a brief justification.

4. Encoding
a) Using the 4B/5B encoding map table present at Table 2.2 of Peterson and Davie(5th edition), write the 4B/5B encoding and draw the resultant NRZI encoding for the following bit sequence:

1110 1101 1011 0000 1111 1010
b) Encode the bit sequence given in part (a) using the Manchester encoding.
c) Which among the two 4B/5B and Manchester encoding is better? Give a brief reason.

5. Byte Stuffing
BISYNC is a sentinel based framing approach wherein the payload (data portion) of the frame is present between two sentinel characters STX (start-of-text) and ETX (end-of-text). The stuffing is done with an escape character DLE (data-link-escape). Following frame (excluding SYNs) message is received on the wire:

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0x4e 0xad 0x32 0x23 0x4e 0x23 0x23 0xbc 0xda 0x23 0xfc 0x14 0xef 0xfc
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Assuming that the above frame has no errors, answer the following-
a) Write down the STX, ETX and DLE bytes in this case.
b) What is the actual payload sent (unstuffed payload)? Remember payload consists of only the characters between the STX and ETX.