CSE 123: Computer Networks
Homework 1
Out: 10/08 Due: 10/15

Instructions
1. Turn in a physical copy at the beginning of the class on 10/15
2. Ensure the HW cover page has the following information clearly written
   a. Name
   b. UCSD email
   c. PID
3. Please contact the TA if you have any issues with the pre-test or associated forms.

1. Pre-Test
In order to better align its courses, the department is conducting a study of students’ readiness for various courses in our curriculum this quarter. Each student needs to complete an on-line pretest which will help both you and the department better assess your background and preparation for this course. While you will not be graded on the accuracy of your responses, a portion of your grade for this assignment depends on your completion of the pretest. We appreciate your assistance with this process. You can find the pretest online at the following URL.

http://www.quia.com/quiz/4966116.html

As explained in Lecture 1, each student also needs to also complete the “pre survey” at the following URL. You only need to fill this out once, regardless of the number of courses you are taking this term that are participating:

https://www.surveymonkey.com/s/LQ66JLZ

Finally, we require your explicit consent so the department can use the data collected to better align the curriculum. The results are anonymous; your identity will not be revealed to those grading the exam. You need to fill this out separately for each class for which you are taking a pre-test:

https://www.surveymonkey.com/s/CRRMQWN

Note that you complete each of these in one sitting. There is no way to save them and go back to them, and you only get one try. The quiz starts when you click the start button. From then on you should NOT do any of the following:

● Open the quiz in a different tab
● Use the browser’s back or refresh buttons
● Close the browser
2. Transmission Time
   a. Calculate the total time required (measured from the start of transmission at the sender to completion of reception at the receiver) to transfer a 4-MB file over a 5-Mbps link assuming an RTT of 200 ms and an initial 2 x RTT “handshake” using a packet size of 2 KB. You may assume packets can be sent continuously after completion of the handshake (i.e., there is no flow-control delay).
   b. Now, let us generalize this and find the total time required to transfer a file of \( S \) MB assuming an RTT of \( r \) ms, an initial \( k \) x RTT of “handshaking”, a bandwidth of \( B \) Mbps and packet size of \( p \) KB.
   c. Verify that your generalization gives you the right answer when substituted with values from (a). That is, show that by plugging in the values from (a) into the equation you derive for (b), you obtain the answer you provided for part (a).

3. Analyzing the Dial-Up Modem
   The speeds of the erstwhile dial-up modem are stuff of legends. Let us analyze the efficiency of the dial-up modem. A dial-up modem transmits digital data over a voice-grade analog phone line which passes a frequency range of 300 Hz to 3300 Hz.
   a. What is the bandwidth of the analog phone line? What is the minimum SNR required on the line for the dial-up modem to achieve its stated rate of 56 kbps?
   b. If the analog phone-line channel SNR were 25 dB, then what would be the maximum possible speed at which a dial-up modem could communicate?

4. MAVEN Spacecraft
   NASA recently launched a space probe, called MAVEN, designed to study the Martian atmosphere while orbiting Mars. MAVEN uses an X-Band (i.e., RF) communication system to achieve a 550 kbps point-to-point link between it and the Earth station. The distance between Earth and Mars is approximately 55 million km.
   a. Calculate the minimum RTT and the bandwidth-delay product for the link
   b. Let us assume that the space probe sends 10 MB of data back to earth periodically. What would be the total time take for Earth station to get the entire 10MB data? (ie. the time taken for a single 10MB data transfer)

Assume the speed of light through outer space is \( 3 \times 10^8 \text{ m/s} \)

5. Network Architecture
   a. What are the 4 layers in the Internet model of the network architecture?
   b. Give two benefits of a layered architecture.

6. Encoding and Issues with Encoding

   *Bit Sequence: 1 1 0 1 0 0 0 0 0 1 0 1 1 1 1 1*
a. Encode the above bit sequence using the NRZ encoding scheme. The above bit
sequence is indicative of the issues that the NRZ encoding scheme might face.
What are they?
b. Encode the bit sequence using the NRZI encoding scheme. How is this encoding
scheme better than the NRZ scheme?
c. Encode the bit sequence using the Manchester scheme. How does this encoding
improve upon both the NRZ and NRZI scheme? Are there any remaining issues
with this encoding scheme?
d. In what way is the 4B/5B encoding scheme better than Manchester encoding
scheme, if at all?

7. **2B/5B Encoding Scheme**
Similar to a 4B/5B encoding scheme let us concoct a new encoding 2B/5B that is every 2
bits of actual data will have a 5 bit code associated with it.

<table>
<thead>
<tr>
<th>2B</th>
<th>5B</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>0000</td>
</tr>
<tr>
<td>01</td>
<td>10101</td>
</tr>
<tr>
<td>10</td>
<td>11010</td>
</tr>
<tr>
<td>11</td>
<td>01111</td>
</tr>
</tbody>
</table>

a. How many errors can be detected using the above set of codewords?
b. How many errors can be corrected if any?
c. Is this an efficient encoding? Why or why not?
d. What is the efficiency of this 2B/5B encoding scheme?

8. **HDLC Framing**
The following bit sequence arrives over the link

```
0111 1110 1000 0111 1101 1001 1110 1000 0111 1101 1110 1111 0111 1110
```

If the HDLC protocol was used for framing, mark the following
a. Start of frame
b. End of frame
c. Stuffed bits
d. Bits indicating errors